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Foreword

This ETSI Technical Report (ETR) has been prepared by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status.

An ETR may be used to publish material which is either of an informative nature, relating to the use or application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

This ETR contains the specification of the services and facilities of the Trans European Trunked Radio (TETRA) system.

This ETR will be subject to revision and, therefore, future editions.

This ETR is divided into three parts:

Part 1:	**Voice plus Data (V+D) systems;**
Part 2:	Packet Data Optimized (PDO) systems;
Part 3:	Security aspects.

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1 Scope

This ETSI Technical Report (ETR) outlines the technical requirements specification for the Trans European Trunked Radio (TETRA) system. It represents the evolutionary development of the Interim European Telecommunication Standards (I-ETSs) for TETRA. Two standards are planned:

- Voice plus Data (V+D);
- Packet Data Optimized (PDO).

The V+D standard can be used for any mixture of voice and data services using both circuit and packet mode data. Therefore it will be permissible to implement a voice only mix, a voice and data mix, and a data mix.

By contrast, the PDO standard can only be used for packet mode data services.

The requirements of these two standards are described separately in Parts 1 and 2 of this ETR. The two standards are required to use common elements where possible, and this ETR will identify potential common functions. Part 3 indicates the requirements to cover the Security aspects of TETRA.

This ETR provides the starting point for the system design, and it is the main criteria against which alternative system designs can be judged. It introduces some logical grouping of functions but it should remain implementation independent.

This ETR will define precise performance requirements and where appropriate this includes quantitative values (e.g. a formula to define "grade of service").

This ETR is intended to give a technical "translation" of all of the required services and facilities identified. As part of the translation, the following details will be added:

- the required level of standardization (e.g. the protocol intervention level);
- the interoperability requirement;
- identification of major functional groupings.

2 References

For the purposes of this ETR the following references apply:

[1] ITU-T Recommendation I.140 (1993): "Attribute technique for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[2] CCITT Recommendation I.256 (1988): "Charging supplementary services".

[3] CCITT Recommendation I.340 (1988): "ISDN connection types".

[4] ITU-T Recommendation X.25 (1993): "Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit".

[5] I-ETS 300 113 (1992): "Radio equipment and systems, Land mobile service, Technical characteristics and test conditions for non-speech and combined analogue speech/non-speech equipment with an internal or external antenna connector, intended for the transmission of data".

[6] prETS 300 580 (1993): "European digital cellular telecommunication system (Phase 2); Principles of Telecommunication Services supported by a GSM Public Land Mobile Network (PLMN)".

[7] ETR 086-2 (1994): "Trans European Trunked Radio (TETRA) system; Technical requirements specifications Part 2: Packet Data Optimised (PDO) systems".

[8] ISO 7498-2 (1989): "Information processing systems - Open Systems Interconnection - Basic Reference Model - Part 2: Security Architecture".

3 Definitions and abbreviations (TETRA 01.04)

3.1 Definitions

For the purposes of this ETR the following definitions apply:

Access control: the prevention of unauthorized use of resources, including the use of a resource in an unauthorized manner.

Authentication: the act of positively verifying that the true identity of an entity (network, user) is the same as the claimed identity.

Base Radio Stack (BRS): a logical grouping that includes all of the air interface protocol element in one base station (the fixed side of the air interface).

Base Station (BS): a physical grouping of equipment which provides the fixed portion of the air interface. One base station transmits and receives radio signals to and from a single location area (a single region of geographical coverage). A BS contains at least one Base Radio Stack (BRS).

Base Station Radio Part (BSRP): one physical sub-group of a base station which contains all the radio end points (one or more) that are connected to a single antenna system.

Bearer service: a type of telecommunication service that provides the capability for the transmission of signals between user-network interfaces.

Bi-directional channel: a channel that can carry information in both directions.

Broadcast call: a multipoint call in which the same information is transmitted simultaneously by the calling terminal to all available terminals.

Call: a complete information exchange between two or more parties.

NOTE 1: See also call transaction.

Call re-establishment (slow handover): the action of switching a call in progress from one cell to another or between radio channels in the same cell.

NOTE 2: Call re-establishment is used to allow established calls to continue when mobile stations move from one cell to another cell, or as a method to escape from co-channel interference.

Call transaction: all events associated with one continuous transmission of information during a call (including control signalling). A call consists of one or more call transactions.

NOTE 3: In a half-duplex call, the call consists of a sequence of unidirectional transactions.

Carrier (Radio Frequency (RF) carrier): the centre frequency of one radio transmission. A modulated carrier is used either for one uplink or one downlink.

Carrier pair: two different carriers which are allocated together to provide one uplink and one downlink. Normally the two carriers are allocated at a fixed frequency spacing (the duplex separation).

NOTE 4: Carrier pairs only refer to allocation of carriers, not to their use. For example, a bi-directional logical channel may be assigned to an uplink from one carrier pair plus a downlink from a different carrier pair.

Cell: the smallest geographical area where TETRA services may be obtained, using a certain set of radio frequencies.

NOTE 5: Each adjacent cell (touching or overlapping) should use a different set of radio frequencies to avoid co-channel interference.

Challenge-Response pair (C/R): a pair of 32 bit binary numbers linked by a security algorithm.

NOTE 6: When a user pays a subscription a key is distributed by the operator. This key is also stored in the subscriber information database.

Circuit switched connection: a connection that is established on request between two or more terminals and provides the exclusive use of the connection for information transfer until it is released.

Circuit switched data service: a data service that uses a circuit-switched connection to transfer data between data terminal equipment.

Circuit switched speech service: a service that uses a circuit-switched connection to transfer speech information between voice terminal equipment.

Closed user group: a (logical) group of users who are not allowed to communicate outside their group.

NOTE 7: Gateways to other networks and to particular subscribers may be accessible as a supplementary service.

Confidentiality (1): rendering information into the form of ciphertext, such that the information is only intelligible by entities that possess the reverse algorithm (i.e. the ability to recover the plaintext from the ciphertext).

Confidentiality (2): the property that information may not be available or disclosed to unauthorized individuals, entities or processes.

Connectionless packet data service: a service which transfers a single packet of data from one source node to one or more destination nodes in a single phase (i.e. without establishing a logical connection or virtual circuit).

Connection oriented packet data service: a service that transfers data from one source node to one destination node using a multi-phase protocol that establishes (and releases) logical connections or virtual circuits between end users that are then used to transferring packet data.

Data compression: a reversible process that reduces the quantity of data, without any loss of information.

Data integrity: the property that data has not been altered or destroyed in an unauthorized manner.

Data origin authentication: the corroboration that the origin of the source of data received is as claimed.

Direct mode: a mode of simplex operation where mobile subscriber radio units may communicate using radio frequencies which are outside the control of the network and without intervention of any base station.

Downlink: a unidirectional radio pathway for the transmission of signals from one Base Station (BS) to one or more Mobile Stations (MSs).

Duplex (full duplex): a mode of operation by which information can be transferred in both directions and where the two directions are independent. See also half duplex.

NOTE 8: In a packet switching environment (PDO or V+D signalling) protocols can be duplex at one layer and half duplex at another layer.

Encryption: the conversion of plaintext to ciphertext.

End to end: is within the TETRA boundaries:

- from TETRA terminal to TETRA terminal (LS or MS);
- from TETRA terminal to gateways;
- including inter system interface.

External user: an application which does recognize TETRA messages and cannot therefore directly invoke TETRA services.

NOTE 9: An external user may be involved in communications which also involve TETRA equipment, but the external user has no direct control over the TETRA facilities.

Facility: the means to assist the performance of an action.

Gateway: a device which will enable the interconnecting of two networks which inherently use different and incompatible protocols.

Half duplex (semi duplex): a mode of operation by which information can be transferred in both directions but the transfers are mutually dependent (i.e. uplink and downlink transfers share some resources). See also duplex.

NOTE 10: In a packet switching environment (PDO or V+D signalling) protocols can be duplex at one layer and half duplex at another layer.

Home Data Base (HDB): the data base in the MS's home TETRA network. In the HDB all necessary information about the MS is collected and stored permanently. Also information about how to find a migrating MS is stored in the HDB. There is logically only one data base in a TETRA network.

Identity exchange: a procedure in which the individual MS identity (i.e. ITSI, ISSI or ASSI) is exchanged for an alias identity (i.e. ISSI or ASSI).

NOTE 11: This is carried out for one of two purposes, either for security purposes where the real ISSI is not sent over the air interface or for exchanging a migrating MS's long ITSI identity to an unambiguous short ISSI or ASSI identity.

Implicit registration: is when the location of the MS is noticed through messages other then location updating messages, e.g. CC messages.

Incoming call: a terminating call which, from the viewpoint of an individual party, is a call that was initiated by another party.

NOTE 12: See also outgoing call.

Inter-operability: an attribute that describes the ability of a given subscriber terminal to obtain service from a given infrastructure, using the appropriate standard TETRA interface protocols.

NOTE 13: See also level of inter-operability and profile.

Inter-system inter-working capability: the ability of a particular TETRA infrastructure to exchange meaningful information with other TETRA infrastructures, using the standard TETRA inter-system inter-working protocols.

NOTE 14: An infrastructure can be characterized by the combination of its inter-system inter-working capability and its air interface profile. See also the definition of profile, and level of inter-working.

Key: a sequence of symbols that controls the operations of encipherment and decipherment.

Key management: the generation, selection, storage, distribution, deletion, archiving and application of keys in accordance with a security policy.

Level of inter-operability: the maximum level of service that can be obtained from a particular pair of equipment (one subscriber terminal and one infrastructure).

NOTE 15: See also interoperability and profile.

Level of inter-working: the maximum level of inter-system inter-working information transfer that is possible between a particular pair of equipment's (i.e. between two particular TETRAs).

NOTE 16: See also inter-system inter-working capability.

Local Line Connected Terminal (LLCT): a type of subscriber terminal which allows a TETRA user to communicate via a cable which is linked directly (i.e. not via a transit network) to the TETRA Switching and Management Infrastructure (SwMI).

Location Area (LA): an area within a TETRA network that may comprise one, several or all cells. An MS may move freely without re-registering within a location area. An MS has continuity of service within a location area. A location area is geographically static.

Logical channel: a logical communications pathway between two or more parties. A logical channel may be unidirectional or bidirectional.

Message trunking: a method of traffic channel organization where each traffic channel is permanently allocated for the complete duration of the call, which may included several separate call transactions (several pressel activations by separate terminals). The channel is only de-allocated if the call is (explicitly) released or if a timeout expires.

NOTE 17: See also transmission trunking, quasi-transmission trunking, statistical multiplexing and quasi-statistical multiplexing.

Migration: the change of location area, each belonging to different TETRA network.

Mobility: the act of a subscriber terminal changing its physical location.

Multicast: the transmission of the same information from one source node to a defined set of destination nodes.

Multiple registration: when a mobile is allowed to simultaneously be registered in more than one location area.

Mobile Radio Stack (MRS): a logical grouping that includes all of the air interface protocol element in one MS (the mobile side of the air interface).

Mobile Station (MS): a physical grouping that contains all of the mobile equipment that is used to obtain TETRA services. By definition, a mobile station contains at least one Mobile Radio Stack (MRS).

Network: a collection of subscriber terminals interconnected through telecommunications devices.

Network management entity: an entity that has access to all parts of the network.

Node: a point at which a packet is manipulated (e.g. sourced, sunk, routed or switched).

Open channel: a dedicated traffic channel that is reserved for the exclusive use of a closed user group.

NOTE 18: See also pseudo open channel.

Outgoing call: a call which, from the viewpoint of an individual participant in the call, is initiated by that participant.

NOTE 19: See also incoming call.

Phase: one discrete part of a procedure, where the start and end of the part can be clearly identified (e.g. by the dispatch of a primitive).

Plaintext: information (including data) which is intelligible to all entities.

Primitive: a distinct data elements that is exchanged between adjacent protocol layers.

NOTE 20: A primitive may be defined in either an abstract or concrete format.

NOTE 21: A service primitive contains one Service Data Unit (SDU).

Private system: a TETRA system established by a private organization so that a group of subscriber terminals that are part of the system can establish calls between one another using the facilities of the private TETRA system.

Process: the exact mechanism whereby a given service is performed.

NOTE 22: If a service conforms to a standard process, it should be performed according to the process defined in the standard.

Profile: the capability of a particular equipment. This is defined separately for individual subscriber terminals and individual infrastructures.

NOTE 23: See also inter-operability and level of inter-operability.

Provision: the act of supplying a given service.

NOTE 24: A Switching and Management Infrastructure (SwMI) may be capable of supporting a service. However, it may not supply the service to certain subscriber terminals for which the service is not subscribed.

Pseudo open channel: a method of assigning traffic channels to a closed user group such that the group appear to have exclusive use of a dedicated traffic channel.

NOTE 25: See also open channel.

Public system: a TETRA network which is established and operated by an organization for the purpose of providing services to subscribing members of the public and third party organizations.

Quasi-statistical multiplexing (quasi-statistical trunking): a multiplexing method which assigns one or more traffic channels to packets from several sources on an "as-needed" basis. Each packet is assigned to one channel, but several packets may be served by a given channel at the same time (the channel capacity being shared amongst them).

NOTE 26: See also transmission trunking, message trunking, quasi-transmission trunking and statistical multiplexing.

Quasi-transmission trunking: a method of traffic channel organization where each traffic channel is allocated for the each call transaction (while the pressel is activated) and in addition the channel de-allocation is delayed for a short period at the end of the transaction (after the pressel release). During this "channel hold-time" the channel allocation may be re-used for a new call transaction that is part of the same call. A delayed channel de-allocation procedure will apply at the end of each transaction.

NOTE 27: See also transmission trunking, message trunking, statistical multiplexing, and quasi-statistical multiplexing.

Radio End Point (REP): the location of the radio function of transmitting or receiving on one carrier.

NOTE 28: A base station will contain several radio endpoints, typically half will be transmitters and half will be receivers.

Radio Packet Data Infrastructure (RPDI): all of the TETRA equipment for a Packet Data Optimised (PDO) network except for subscriber terminals. The RPDI enables subscriber terminals to communicate with each other via the RPDI.

NOTE 29: The RPDI may also make it possible for subscriber equipment to communicate via other transit networks to external applications. MSs can access the RPDI using the air interface.

Registered Area (RA): the total area for which a MS is currently registered. The RA is defined by the list of location areas contained in the latest successful registration.

NOTE 30: The registered area may be non-contiguous.

Registration: a function which allows an MS to tell the TETRA network that it has changed location area (roaming or migration), TETRA subscriber identity or mode of operation. This function enables the network to keep track of the MS.

Roaming: the change of location area within the same TETRA network.

Remote Line Connected Terminal (RLCT): a type of subscriber terminal which allows a TETRA user to communicate via a pathway which includes a transit network and the TETRA Switching and Management Infrastructure (SwMI).

Repudiation: denial by one of the entities involved in a communication of having participated in all or part of a communication.

Search Area (SA): an area comprising all location areas where a MS may search for service.

Security service: a service provided by a layer of communicating open systems which ensures adequate security of the systems or of data transfers.

Signalling: the exchange of Information specifically concerned with the establishment and control of connections, and with management, in a telecommunication network.

Statistical multiplexing: a multiplexing method which assigns one or more traffic channels to packets from several sources on an "as-needed" basis. Each packet is assigned to one channel, and each channel serves the packets sequentially (each packet is completed before a new packet is started).

NOTE 31: See also transmission trunking, message trunking, quasi-transmission trunking and quasi-statistical multiplexing.

Subscriber terminals: an equipment which an internal user can use to communicate with another user. Mobile Stations (MS), Local Line Connected Terminals (LLCT) and Remote Line Connected Terminals (RLCT) are the only types of subscriber terminal.

Supplementary service: a supplementary service modifies or supplements a bearer service or a teleservice. A supplementary service cannot be offered to a customer as a stand alone service. It should be offered in combination with a bearer service or a teleservice.

Switching and Management Infrastructure (SwMI): all of the TETRA equipment for a Voice plus Data (V+D) network except for subscriber terminals. The SwMI enables subscriber terminals to communicate with each other via the SwMI.

NOTE 32: The SwMI may also make it possible for subscriber equipment to communicate via other transit networks to external applications. Mobile Stations (MS) can access the SwMI using the air interface.

Teleservice: a type of telecommunications service that provides the complete capability, including terminal equipment functions, for communication between users according to agreed protocols.

Tetra Equipment Identity (TEI): an electronic serial number which is permanently connected to the TETRA equipment. When it is transmitted over the air interface, it is protected by an algorithm.

Threat: a potential violation of security.

Transaction (packet transaction): all the processes and procedures associated with the transmission of one packet of information between peer network layer protocol entities on opposite sides of the air interface.

Transaction (voice transaction): all of the processes and procedures associated with the unidirectional transmission of one packet of (user) information between network layer service boundaries that lie on opposite sides of the air interface.

Transmission trunking: a method of traffic channel organization where each traffic channel is individually allocated for each call transaction (for each activation of the pressel). The channel is immediately de-allocated at the end of the call transaction (subject to unavoidable protocol delays).

NOTE 33: See also message trunking, quasi-transmission trunking, statistical multiplexing and quasi-statistical multiplexing.

Two-frequency simplex: a physical layer mode of operation, where a radio end point is either receiving on one RF carrier or transmitting on another (different) RF carrier. The transmit and receive operations are dependent; transmission implies no reception, and reception implies no transmission.

Two-frequency simultaneous duplex (two frequency duplex) (two frequency full duplex): a physical layer mode of operation where a radio end point is receiving on one RF carrier and transmitting on another (different) RF carrier at the same time (the periods of transmission and reception are not separated in time). The transmit and receive operations are independent.

NOTE 34: The word duplex always implies the existence of independent transmit and receive operations. A duplex radio requires extra processing compared to a simplex radio.

Two frequency time division duplex (two frequency semi-duplex) (two frequency half-duplex): a physical layer mode of operation where a radio end point is receiving on one RF carrier and also transmitting on another (different) RF carrier, but the periods of transmission and reception are displaced (interleaved) in time. The transmit and receive operations are independent.

Unidirectional channel: a channel that can only carry information in one direction.

Uplink: a unidirectional radio communication pathway for the transmission of signals from one or more MSs to one BS.

Visited Data Base (VDB): is the data base in a visited TETRA network. When an MS has migrated to a TETRA network and exchanged its ITSI to an ISSI or an ASSI belonging to the VDB, subsequent roaming will take place in the visited network without contact with the HDB. There is logically only one VDB per TETRA system.

3.2 General abbreviations

For the purposes of this ETR the following general abbreviations apply:

ASSI	Alias Short Subscriber Identity
ATSI	Alias TETRA Subscriber Identity
BS	Base Station
C/R	Challenge-Response pair
CL (C/L)	Connectionless
CLNP	Connectionless Network Protocol
CLNS	Connectionless Network Service
CMCE	Circuit Mode Control Entity
CO (C/O)	Connection Oriented
CONP	Connection-Oriented Network Protocol
CONS	Connection-Oriented Network Service
DCE	Data Circuit-terminating Equipment
DGNA	Dynamic Group Number Assignment
DLC	Data Link Control
DM	Direct Mode
DTE	Data Terminating Equipment

ETSI	European Telecommunications Standards Institute
GSSI	Group Short Subscriber Identity
GTSI	Group TETRA Subscriber Identity
HDB	Home Data Base
ISDN	Integrated Services Digital Network
ISI	Inter System Interface
ISO	International Organisation for Standardisation
ISSI	Individual Short Subscriber Identity
ITSI	Individual TETRA Subscriber Identity
LA	Location Area
LLC	Logical Link Control
LS	Line Station
MAC	Medium Access Control
MCC	Mobile Country Code (Identity), part of ITSI
MLE	Mobile Link Entity
MM	Mobility Management
MNC	Mobile Network Code (Identity), part of ITSI
MS	Mobile Station
MSI	Mobile Subscriber Identity
MT	Mobile Termination
MTU	Mobile Terminating Unit
NT	Network Termination
NWK	Network
OSI	Open Systems Interconnection
PAD	Packet Assembler/ Disassembler
PD	Protocol Discriminator
PDN	Public Data Network
PDO	Packet Data Optimised
PDU	Protocol Data Unit
PICS	Protocol Implementation Conformance Statement
PSTN	Public Switched Telephone Network
PTN	Private Telephone Network
PTNX	Private Telephone Network eXchange
PVC	Permanent Virtual Circuit
RES-6	ETSI Sub-Technical Committee RES-6 (Radio Equipment and Systems - 6)
RA	Registered Area
RPDI	Radio Packet Data Infrastructure
RPDN	Radio Packet Data Network
S-CLNP	Specific Connectionless Network Protocol
S-CLNS	Specific Connectionless Network Service
SA	Search Area
SAP	Service Access Point
SDL	(Functional) Specification and Description Language
SDU	Service Data Unit
SNAcP	Sub-Network Access Protocol
SNDCP	Sub-Network Dependent Convergence Protocol
SNICP	Sub-Network Independent Convergence Protocol
SS	Supplementary Service

NOTE: The abbreviation SS is only used when refering to a specific Supplementary Service.

SwMI	Switching and Management Infrastructure
TBD	To Be Determined
TDC	Transient Data Channel
TE	Terminal Equipment
TEI	TETRA Equipment Identity
TETRA	Trans European Trunked RAdio
TMI	TETRA Management Identity
USSI	Unexchanged Short Subscriber Identity
V+D	Voice Plus Data
VC	Virtual Call
VDB	Visited Data Base
VPA	Virtual Point of Attachment

X.25 PLP	X.25 Packet Layer Protocol (Layer 3 of ITU-T Recommendation X.25 [4])

3.3 Supplementary service abbreviations

AL	Ambience Listening
AoC	Advice of Charge
AP	Access Priority
AS	Area Selection
BIC	Barring of Incoming Calls
BOC	Barring of Outgoing Calls
CAD	Call Authorized by Dispatcher
CCBS	Call Completion to Busy Subscriber
CCNR	Call Completion on No Reply
CFB	Call Forwarding on Busy
CFNRy	Call Forwarding on No Reply
CFNRc	Call Forwarding on Mobile Subscriber Not Reachable
CFU	Call Forwarding Unconditional
CLIP	Calling Line Identification Presentation
CLIR	Calling/Connected Line Identification Restriction
COLP	Connected Line Identification Presentation
CR	Call Report
CRT	Call Retention
CW	Call Waiting
DGNA	Dynamic Group Number Assignment
DL	Discreet Listening
HOLD	Call Hold
IC	Include Call
LE	Late Entry
LSC	List Search Call
PC	Priority Call
PPC	Pre-emptive Priority Call
SNA	Short Number Addressing
TC	Transfer of Control of Call
TPI	Talking Party Identification

4 Principles used in this ETR (TETRA 02.02)

4.1 The attribute methodology

Attributes are used in the characterization of services and network capabilities provided by TETRA in a structured simple manner and to highlight the important aspects of the object.

In addition to describing service capabilities, the identification of the attributes facilitates the specification of network interfaces.

This subclause defines a recommended set of bearer service and teleservices categories and further, to describe and define a recommended set of bearer services and teleservices that may be supported by TETRA.

4.1.1 Attribute principles

The Consultative Committee on International Telegraphy and Telephony (CCITT) has defined semi-formal methods to assist with the definition of Integrated Services Digital Network (ISDN) services and network aspects. One of these methods is known as the "attribute technique" and is described in ITU-T Recommendation I.140 [1] and supplemented by CCITT Recommendation I.340 [3]. The technique describes objects in a structured, simple manner, and highlights the salient features of the object. The salient features are termed "attributes". Each attribute is independent of the others so that a change in the value of one will not affect the others. To describe a particular service the attributes are assigned values which identify the service.

The technique is applicable to the characterization of telecommunication services types within the ISDN context, and it is believed that this method forms a suitable technique for the characterization of teleservices and bearer services within the context of TETRA.

Bearer services and teleservices can be fully described by prose definitions and descriptions, by attributes and by dynamic descriptions. Altogether they define the service characteristics as they apply at a given reference point where the customer access the service, and the network capabilities required to be provided to TETRA subscribers.

These services may be either circuit mode or packet mode and their associated capabilities.

4.2 Service definitions

Some definitions are required in order to clearly identify and separate bearer services from teleservices. Figure 1 shows the hierarchical tree of services.

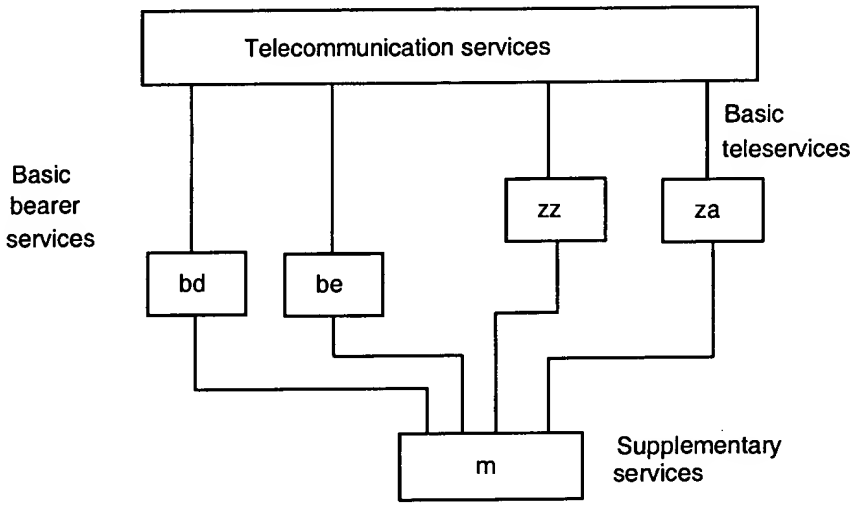

Figure 1: Hierarchical tree of services

4.2.1 Telecommunication service

A telecommunication service is defined as that which is offered by an administration/operator to its customers in order to satisfy a specific telecommunication requirement.

NOTE: Bearer service and teleservice are types of telecommunication service.

4.2.2 Bearer service

A bearer service is defined as a type of telecommunication service that provides the capability for information transfer between user-network interfaces and only involves OSI lower layer functions (layers 1-3).

A customer may choose any set of OSI high layer protocols (layers 4-7) for his communication, but the bearer service will not ascertain compatibility between customers at these layers.

4.2.3 Teleservice

A teleservice is defined as a type of telecommunication service that provides the complete capability, including terminal equipment functions, for communication between users according to protocols established by agreement between operators.

In other words a teleservice provides the user with the possibility of gaining access to various forms of applications via the terminal equipment, (and it is carried through the network by the bearer service). Examples of teleservices are telephony and teletext.

4.2.4 Supplementary service

A supplementary service modifies or supplements a basic telecommunication service. Consequently it cannot be offered to a customer as a stand alone service. It should be offered together with or in association with a telecommunication service. The same supplementary service may be common to a number of telecommunication services.

Examples of supplementary services are Call Forwarding Unconditional (CFU), Call Waiting (CW) and Advice of Charge (AoC).

NOTE: The concept of supplementary services corresponds to the concept of optional user facilities in the X-Series of CCITT Recommendations.

4.2.5 Facilities

The CCITT has considered the need to standardize data transmission services and optional user facilities in data networks which would be made available on an international basis.

These facilities, and the ability of the network to offer certain pre-defined user-selectable functions, would be determined and accessed by use of an inherent protocol, e.g. ITU-T Recommendation X.25 [4] etc.

4.3 The attribute technique

Using the attribute technique, telecommunication characteristics can be described in a manner which ensures completeness and which allows easy comparison between different types of services. By studying a service attribute a user will be able to clearly understand the extent of its capability.

In addition to describing the service capabilities, the identification of the attributes facilitates the specification of network interfaces.

4.4 Framework for describing bearer services

Bearer services provide the capability for information transfer between access points and involve only low layer functions. Bearer services can be described from a static point of view by attributes which are grouped into three groupings:

a) **Dominant Attributes:** these describe the network capabilities for transferring information from one user access point to another. The attributes are known as **"Information Transfer Attributes Type 1"**.

b) **Secondary Attributes:** these further describe the network capabilities for transferring information and consider how the connection is established and configured. These attributes are known as **"Information Transfer Attributes Type 2"**.

c) **Qualifying Attributes Type 1:** these primarily relate to the user interface (access point), and describe the means for accessing network functions or facilities as seen at the access point. These attributes are known as **"Access Attributes"**.

d) **Qualifying Attributes Type 2:** these further specify and qualify the service, with regard to inter-working, quality of service and supplementary services. They are additionally known as **"General Attributes"**.

Annex A, table A.1 gives a detailed list of the attributes, within the three grouping types. Definitions of the attributes are contained in Annex A, Clause A.4.

4.4.1 Bearer services categories

As a first step categories for each of the bearer services should be established. See Annex B, table B.1 for categorization of bearer services.

4.4.2 Category descriptions

It is possible to give an overview of the bearer service categories identified and further a more detailed description.

4.4.2.1 Category number 1

Provides for the transfer for user information at 7,2 kbit/s gross bit rate, such as coded or encrypted speech etc. as determined by the user, across the network using circuit mode operation (i.e. transmission is achieved by the permanent allocation of channels/bandwidth between the users). The category guarantees Time Slot Sequence Integrity (TSSI) of **(TBD)** (15 ms?).

4.4.2.2 Category number 2

Provides for the unrestricted transfer of user digital information without alteration, involving packet handling functions up to **(TBD)** packets/s throughput across the network. (Throughput to be determined).

With a connection oriented service, a station performs a call request to set up a logical connection to another station. All packets presented to the network are identified as belonging to a particular logical connection and are numbered sequentially. The network undertakes to deliver packets in sequence-number order. This implies bit sequence independence, digit sequence integrity and bit integrity. The logical connection is usually referred to as a virtual circuit.

4.4.2.3 Category number 3

Provides for the unrestricted transfer of user digital information without alteration, involving packet handling functions up to **(TBD)** packets/s throughput across the network. (Throughput to be determined).

A connectionless service that allows the transfer of information among users without the need for end-to-end call establishment procedures. It implies that the network agrees to handle packets independently, and may not deliver them in order.

4.4.2.4 Category number 4

Provides for the unrestricted transfer of user digital information in multiple rates of 4,8 kbit/s up to a maximum of 19,2 kbit/s **(TBD)** without alteration, using circuit mode operation (i.e. transmission is achieved by the permanent allocation of channels/bandwidth between the users). These types of categories are typically characterized by the provision of user information over one type of channel and signalling over another type of channel. A standard channel coding is provided for this category.

4.4.2.5 Category number 5

Provides for the unrestricted transfer of user digital information in multiple rates of 4,8 kbit/s up to a maximum of 19,2 kbit/s **(TBD)** without alteration, using circuit mode operation (i.e. transmission is achieved by the permanent allocation of channels/bandwidth between the users). These types of categories are typically characterized by the provision of user information over one type of channel and signalling over another type of channel. No standard channel coding is provided for this category.

4.5 Framework for describing teleservices

Teleservices provide the full capacity for communication by means of terminal and network functions. They can be described from a static point of view by a group of three categories:

a) low layer attributes:

- information transfer attributes;
- access attributes;

b) high layer attributes;

c) general attributes.

NOTE: Teleservices generally make use of underlying lower level capabilities of bearer services specified. However this may not necessarily be true in all cases. Figure 2 shows the relationship between the different categories of services attributes and their scope within a teleservice.

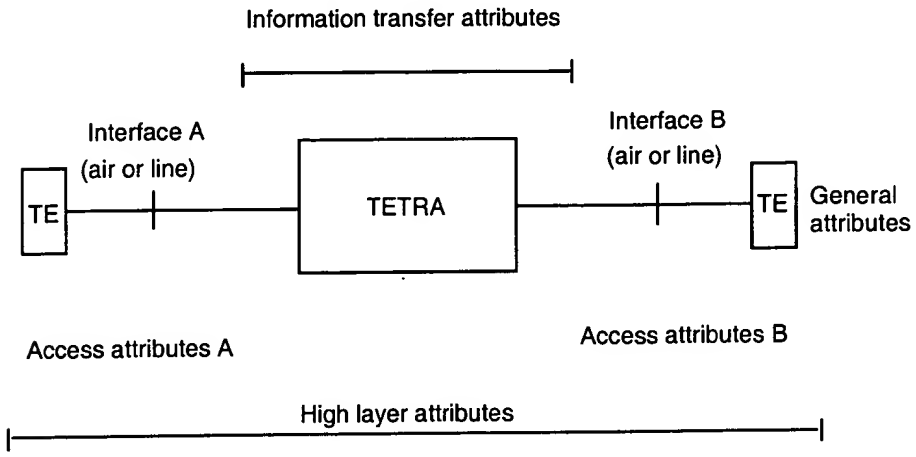

Figure 2: Relationship between the categories of service attributes and their scope within a teleservice

Annex A, table A.2, gives a detailed list of the attributes within the three category types.

NOTE: The "type of user information" is considered to be the only dominant attribute with which to describe the teleservice, (unlike bearer services which have four dominant attributes with which to describe the service).

4.6 Framework for describing supplementary services

Supplementary services supported by TETRA provide additional capabilities to be used with the bearer services and teleservices. They cannot be offered to the customer as a stand alone service.

The use of the attribute technique for supplementary services is for further study.

Supplementary services are characterized by prose descriptions given in Clause 6.

4.7 Reference models

Figure 3 shows the physical reference model for Voice plus Data (V+D) TETRA systems. The purpose of this model is to provide a framework for describing the technical requirements of V+D TETRA systems. This reference model can also be used as a basis for designing the V+D TETRA standard.

The reference model shows three types of subscriber terminal. These are:

1) Line connected Station (LS), which is connected by a direct link to the SwMI;

2) Mobile terminal (MOB), which uses the TETRA air interface to communicate with the SwMI;

3) Other Mobile terminal (OMOB), which is the same as a MOB, but does not belong to the addressing domain of the particular TETRA system described. An OMOB does belong to the addressing domain of another TETRA system.

The Switching and Management Infrastructure (SwMI) is that part of the TETRA system which is run by the operator.

The Internal Voice and Data Users (IVDU) subscribe to services in the particular TETRA system.

The Other Internal Voice and Data Users (OIVDU) subscribe to another TETRA system.

The External Voice and Data User (EVDU) does not use a TETRA subscriber terminal to access TETRA services.

The Recorded Information User (RIU) is a specially authorized user who may listen to recorded communication information.

The Transit Networks (TN) allow extended communication capability.

The other TETRAs are separate TETRA systems which are not part of the TETRA system being modelled.

The various physical interfaces shown allow information to flow between the various physical elements of the model.

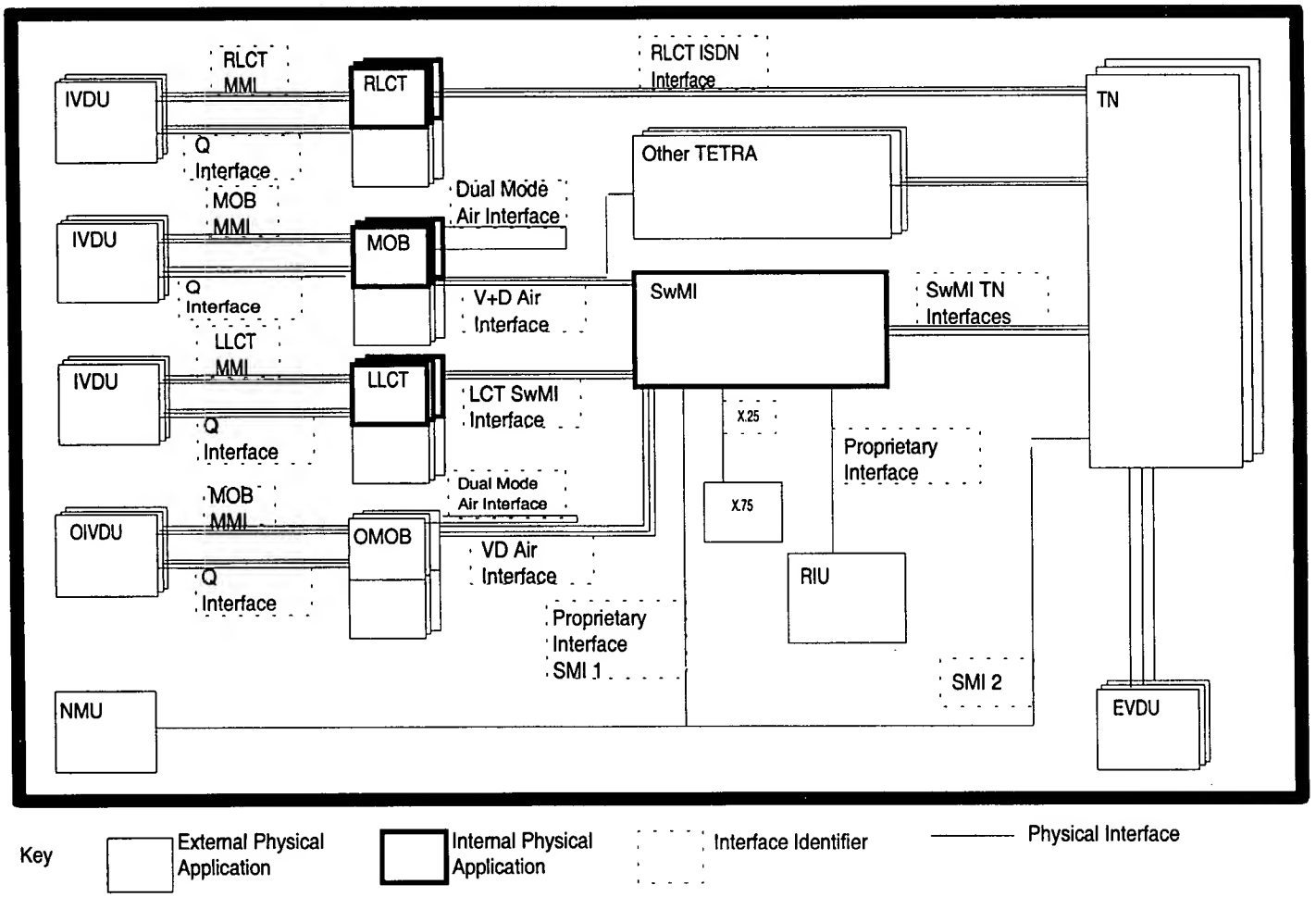

Figure 3: Physical interfaces reference model for V+D TETRA system

5 Voice and data tele/bearer services

5.1 Summary of basic services supported

Table 1 gives a brief summary of the basic services supported for voice and data implementation. It outlines the basic services available for each of the three modes of operation i.e.:

- Circuit Mode (CM);
- Packet Connection Oriented Mode (PCOM);
- Packet Connectionless Mode (PCM).

Table 1: Voice and data services

	Basic teleservice	Basic bearer service	Supplementary service	Facility
TETRA clear speech	Ind. Call (Pt-Pt) Group Call (Multipt) Ack Gp Call (MultiPt) Broadcast (Broadcast)		See table 3	See table 6
TETRA encrypted speech	Ind. Call (Pt-Pt) Group Call (Multipt) Ack Gp Call (MultiPt) Broadcast (Broadcast)		See table 4	See table 6
Circuit mode unprotected speech + data	None	7,2 kbit/s (Pt-Pt) 14,4 kbit/s (Pt-Pt) 21,6 kbit/s (Pt-Pt) 28,8 kbit/s (Pt-Pt) 7,2 kbit/s (Group) 14,4 kbit/s (Group) 21,6 kbit/s (Group) 28,8 kbit/s (Group) 7,2 kbit/s (AkGroup) 14,4 kbit/s (AkGroup) 21,6 kbit/s (AkGroup) 28,8 kbit/s (AkGroup) 7,2 kbit/s (BdCast) 14,4 kbit/s (BdCast) 21,6 kbit/s (BdCast) 28,8 kbit/s (BdCast)	See table 2	See table 6
Circuit mode protected (low) data	None	4,8 kbit/s (Pt-Pt) 9,6 kbit/s (Pt-Pt) 14,4 kbit/s (Pt-Pt) 19,2 kbit/s (Pt-Pt) 4,8 kbit/s (Group) 9,6 kbit/s (Group) 14,4 kbit/s (Group) 19,2 kbit/s (Group) 4,8 kbit/s (AkGroup) 9,6 kbit/s (AkGroup) 14,4 kbit/s (AkGroup) 19,2 kbit/s (AkGroup) 4,8 kbit/s (BdCast) 9,6 kbit/s (BdCast) 14,4 kbit/s (BdCast) 19,2 kbit/s (BdCast)	See table 5	See table 6

(continued)

Table 1: Voice and data services (concluded)

	Basic teleservice	Basic bearer service	Supplementary service	Facility
Circuit mode protected (high) data	None	2,4 kbit/s (Pt-Pt) 4,8 kbit/s (Pt-Pt) 7,2 kbit/s (Pt-Pt) 9,6 kbit/s (Pt-Pt) 2,4 kbit/s (Group) 4,8 kbit/s (Group) 7,2 kbit/s (Group) 9,6 kbit/s (Group) 2,4 kbit/s (AkGroup) 4,8 kbit/s (AkGroup) 7,2 kbit/s (AkGroup) 9,6 kbit/s (AkGroup) 2,4 kbit/s (BdCast) 4,8 kbit/s (BdCast) 7,2 kbit/s (BdCast) 9,6 kbit/s (BdCast)	See table 5	See table 6
Packet connection oriented data	None	Individual TBD Packets (Pt-Pt)	N/A	See ETR 086 Part 2 [7]
Packet connectionless data	None	Individual (Pt-Pt)	N/A	See ETR 086 Part 2 [7]
Special packet connectionless data	None	Individual (Pt-Pt) Broadcast (BdCast) Multipoint (Multipt)	N/A	See ETR 086 Part 2 [7]

5.2 Speech and data unprotected bearer services

Speech bearer services are intended to support speech and data on a point-to-point, point-to multipoint, and broadcast circuit mode configuration. It is envisaged that this service will support non-standardized enciphered speech.

It will be possible for the user to make individual and group calls within a TETRA system, however intelligibility cannot be guaranteed unless end systems use the same higher level protocols.

5.3 CM protected data bearer services

Bearer services intended to support data on a point-to-point, point-to multipoint, and broadcast circuit mode configuration. These services offer varying degrees of protection against bit error.

5.4 Voice teleservices

All of the voice teleservices are standardized to enable the transmission of voice signals only. Therefore, the formal attribute description, as outlined in Annex A, shows that information transfer is unstructured and bit and block integrity cannot be guaranteed for data transmission.

The following subclauses give a prose description of each of the four voice teleservices.

5.4.1 Individual speech calls

An individual call is a two way point-to-point communication between one calling party and one called party.

Individual calls with TETRA clear speech can be originated by any user of the TETRA system. Basically, the call can be placed to any addressable user in the world.

Individual calls with TETRA encrypted speech requires that the call is kept within the TETRA system, however intelligibility cannot be guaranteed unless end systems use the same higher level protocols, i.e. the same manufacturer equipment.

The call may be cleared by the call originator or the called party.

The normal mode of operation is semi duplex, but full duplex may be possible as an operator option, (possibly depending on the call type e.g. PSTN access).

5.4.2 Multipoint speech calls

5.4.2.1 Group call

A Group Call is a two way point-to-multipoint communication between a calling party and one or more called parties.

Group Calls can be initiated either by a line connected terminal or a mobile. The group can consist of both mobiles (i.e. radio connected terminals) and line connected terminals.

The members of a group have one common predefined number which is called their group number and by which they are addressed.

An MS or LS can be assigned a group number in two ways:

- statically and permanently assigned by the operator when the system is configured;
- dynamically assigned by an authorized user or operator.

Only one number (GSSI) is sent on the air interface and no acknowledgement is expected. The primary objective is to have a fast call set up. If the mobiles are distributed over several sites this group number may be transmitted on each site where a member of the group is registered. The group call will use a maximum of one traffic channel on each site.

It is the responsibility of the infrastructure to gather the concerned LSs to the group call. How this is achieved is for further study. (A possible solution is that the infrastructure will know the members of the group, and will know which of those members are Mobile Stations and which are LSs. The infrastructure may chose to contact the LSs by their ISSIs in order to gather them to the group call).

There may be a problem to include LSs in the group, because it will probably take a longer time to connect a call through other networks compared to TETRA (TETRA requires 300 ms call set up time). However, the standard should not preclude the use of LSs in group calls.

The group call can be cleared only by the call owner. The call initiator is the default call owner. Call control may be passed to another participating group call member using the "Transfer of Control" supplementary service.

It is assumed that the conversation is carried out in semi duplex mode and all users (radio or line connected) participating in the group call should have a press to talk switch or equivalent. In order to enhance system performance it is assumed that LSs have press to talk switches. If the group call is initiated from e.g. a PABX, where subscribers do not have press to talk switches, some other means for communicating the press to talk function should be employed.

Group calls with TETRA encrypted speech requires that the call is kept within the TETRA system, however intelligibility cannot be guaranteed unless end systems use the same higher level protocols.

5.4.2.1.1 Group call clear down procedure

The group call owner is responsible for all aspects of the call. The group call is normally cleared down when the call owner disconnects the call.

5.4.2.2 Acknowledged group call

An acknowledged group call is a two way point-to-multipoint communication between a calling party and several called parties.

The call is set up in the normal way as a group call and the call is sent to the traffic channel. It is an operator option if the call is to immediately proceed, by giving the originator of the call the right to transmit.

The members of the acknowledged group are known to the infrastructure and they are polled by their individual identities on the traffic channel for their presence. Those present on the traffic channel should acknowledge the poll. It is an operator option if the presence checking continues beyond the point where the originator of the call has been given permission to transmit.

The presence check is stopped if the call is disconnected.

The call is allowed to proceed when the criteria for the call has been reached, i.e. sufficient members of the group are present. The calling party is informed of the parties present and may be given the option to proceed with the call.

It is an operator option to disconnect the call if it has been shown that insufficient members are present and the right to transmit has not been given.

The group can consist of both MSs and LSs.

It is assumed that communication is carried out in semi duplex mode and all users (radio or line connected) participating in the group call have a press to talk switch or equivalent. If the group call is initiated from e.g. a PABX, where subscribers do not have press to talk switches, some other means for communicating the press to talk function (such as voice activity detector) should be employed.

Acknowledged group calls with TETRA encrypted speech requires that the call is kept within the TETRA system, however intelligibility cannot be guaranteed unless end systems use the same higher level protocols.

5.4.2.2.1 Acknowledged group call clear down procedure

The acknowledged group call owner is responsible for all aspects of the call. The acknowledged group call is cleared down only when the call owner disconnects the call.

5.4.2.3 Broadcast message

A broadcast message is a one way point-to-multipoint communication between a calling party and several called parties.

Broadcast messages can be originated either by a line connected terminal or a mobile. The recipients of a broadcast message are called a broadcast group. The broadcast group can consist of both mobiles (i.e. radio connected terminals) and line connected terminals.

The members of the group have one common number which is called their broadcast group number, by which they are addressed. This number could be the same as the "ordinary "group number. Only one number (MSI) is sent on the air interface and normally no acknowledgement is expected. The primary objective is to have a fast call set up. If the mobiles of the broadcast group are distributed over several sites this broadcast group number may be transmitted on each site where a member of the broadcast group is registered. Alternatively, if the operator so wishes, the broadcast group number can be sent on all sites in order to simplify the implementation. The broadcast message service will use a maximum of one traffic channel on each site.

It is an operator option that acknowledgements from the broadcast group can be returned. This could be used, for example, in the case of a dispatcher interested to know who in the broadcast group is listening.

The LSs of the group are all called individually in parallel with the mobiles by using the common broadcast group number, and in the same way as for the mobiles no acknowledgement is expected.

It is assumed that the communication is strictly one way and the called parties cannot respond on the information.

The broadcast message can only be cleared by the originator of the call.

In order to incorporate external users to a broadcast call, there is a possibility to translate the group number in the infrastructure to an individual call to a PABX/PSTN/ISDN subscriber. This is however considered to be outside the scope of the TETRA standard.

Broadcast calls with TETRA encrypted speech require that the call is kept within the TETRA system, however intelligibility cannot be guaranteed unless end systems use the same higher level protocols, i.e. the same manufacturer equipment.

5.5 Data bearer services

The formal attribute descriptions of each of the 54 bearer services are outlined in Annex B. The following subclauses give a prose description of each of three bearer service categories.

5.5.1 Packet mode connection oriented data

As for TETRA packet data optimised service, see ETR 086 Part 2 [7].

5.5.2 Packet mode connectionless data

Refer to ETR 086 Part 2 [7].

5.5.3 Specific packet mode connectionless data

Refer to ETR 086 Part 2 [7].

5.5.4 Circuit mode data

5.5.4.1 Circuit mode protected data

This service provides the user with a {1,2,3,4}*4,8 kbit/s standard channel coded bearer. See Annex C for a full description of the service. Acknowledged group calls are for further study.

5.5.4.2 Circuit mode unprotected data

This service provides the user with a {1,2,3,4}*7,2 kbit/s non channel coded bearer. See Annex B for a full description of the service. Acknowledged group calls are for further study.

5.6 Packet data teleservices

No packet data teleservices are envisaged.

5.7 Packet mode data supplementary services

None are envisaged.

5.8 Data facilities

5.8.1 Circuit mode data facilities

None are envisaged.

5.8.2 Packet mode connection oriented data facilities

This subclause proposes a set of facilities to be made available to the user in the TETRA packet switched data bearer service.

Refer to ETR 086 Part 2 [7].

5.8.3 Specific packet mode connectionless data facilities

Refer to ETR 086 Part 2 [7].

6 Supplementary services

6.1 Introduction

Table 2 shows which supplementary services can be accessed by the circuit mode speech and data bearer service and tables 3 and 4 shows which supplementary services can be accessed by the speech teleservices. Table 5 shows which supplementary services can be accessed by the circuit mode data bearer services (protected and unprotected).

Table 2: Mapping of supplementary services onto circuit mode speech and data bearer services

Item no	Supplementary service description	Point-to-point call	Multipoint call	Broadcast call
1	List search call	X		
2	Include call	X	X	
3	Call forwarding unconditional	X	X	X
4	Call forwarding busy	X	X	X
5	Call forwarding on no reply	X	X	X
6	Call forwarding on not reachable	X	X	X
7	Call authorized by dispatcher	X	X	X
8	Barring of incoming calls	X	X	X
9	Barring of outgoing calls	X	X	X
10	Call report	X		
11	Call waiting	X	X	X
12	Calling line identification presentation	X	X	X
13	Connected line identification presentation	X		
14	Calling/connected line ident restriction	X	X	X
15	Call hold	X	X	X
16	Call completion to busy subscriber	X		
17	Call completion on no reply	X		
18	Short number addressing	X	X	X
19	Priority call	X	X	X
20	Pre-emptive priority call	X	X	X
21	Access	X	X	X
22	Advice of charge	X	X	X
23	Discreet listening	X	X	X
24	Ambience listening	X		
25	Talking party identification	X	X	X
26	Area selection	X	X	X
27	Late entry		X	X
28	Transfer of control	X	X	
29	Dynamic group number assignment		X	X
30	Call retention	X	X	X

Table 3: Mapping of supplementary services onto TETRA clear speech teleservices

Item no	Supplementary service description	Individual call	Group call	Acknowledged group call	Broadcast message
1	List search call	X			
2	Include call	X	X		
3	Call forwarding unconditional	X	X	X	X
4	Call forwarding busy	X	X	X	X
5	Call forwarding on no reply	X	X	X	X
6	Call forwarding on not reachable	X	X	X	X
7	Call authorized by dispatcher	X	X	X	X
8	Barring of incoming calls	X	X	X	X
9	Barring of outgoing calls	X	X	X	X
10	Call report	X			
11	Call waiting	X	X	X	X
12	Calling line ident presentation	X	X	X	X
13	Connected line ident presentation	X			
14	Calling/connected line ident restrict	X	X	X	X
15	Call Hold	X	X	X	X
16	Call completion to busy subscriber	X			
17	Call completion on no reply	X			
18	Short number addressing	X	X	X	X
19	Priority call	X	X	X	X
20	Pre-emptive priority call	X	X	X	X
21	Access priority	X	X	X	X
22	Advice of charge	X	X	X	X
23	Discreet listening	X	X	X	X
24	Ambience listening	X			
25	Talking party identification	X	X	X	
26	Area selection	X	X	X	X
27	Late entry		X	X	X
28	Transfer of control	X	X	X	
29	Dynamic group number assign		X	X	X
30	Call retention	X	X	X	X

Table 4: Mapping of supplementary services onto TETRA encrypted speech teleservices

Item no	Supplementary service description	Individual call	Group call	Acknowledged group call	Broadcast message
1	List search call	X			
2	Include call	X	X		
3	Call forwarding unconditional	X	X	X	X
4	Call forwarding busy	X	X	X	X
5	Call forwarding on no reply	X	X	X	X
6	Call forwarding on not reachable	X	X	X	X
7	Call authorized by dispatcher	X	X	X	X
8	Barring of incoming calls	X	X	X	X
9	Barring of outgoing calls	X	X	X	X
10	Call report	X			
11	Call waiting	X	X	X	X
12	Calling line ident presentation	X	X	X	X
13	Connected line ident presentation	X			
14	Calling/connected line ident restrict	X	X	X	X
15	Call hold	X	X	X	X
16	Call completion to busy subscriber	X			
17	Call completion on no reply	X			
18	Short number addressing	X	X	X	X
19	Priority call	X	X	X	X
20	Pre-emptive priority call	X	X	X	X
21	Access priority	X	X	X	X
22	Advice of charge	X	X	X	X
23	Discreet listening	X	X	X	X
24	Ambience listening	X			
25	Talking party identification	X	X	X	
26	Area selection	X	X	X	X
27	Late entry		X	X	X
28	Transfer of control	X	X	X	
29	Dynamic group number assign		X	X	X
30	Call retention	X	X	X	X

Table 5: Mapping of supplementary services onto circuit mode protected and unprotected data

Item no	Supplementary service description	Individual call
1	List search call	X
2	Include call	
3	Call forwarding unconditional	X
4	Call forwarding busy	X
5	Call forwarding on no reply	X
6	Call forwarding on not reachable	X
7	Call authorized by dispatcher	X
8	Barring of incoming calls	X
9	Barring of outgoing calls	X
10	Call report	X
11	Call waiting	X
12	Calling line identification presentation	X
13	Connected line identification presentation	X
14	Calling/connected line identification restriction	X
15	Call hold	X
16	Call completion to busy subscriber	X
17	Call completion on no reply	X
18	Short number addressing	X
19	Priority call	X
20	Pre-emptive priority call	X
21	Access priority	X
22	Advice of charge	X
23	Discreet listening	X
24	Ambience listening	
25	Talking party identification	
26	Area selection	X
27	Late entry	
28	Transfer of control	
29	Dynamic group number assignment	
30	Call retention	X

6.2 List Search Call (LSC)

The LSC supplementary service allows a served user to define a list of attendants so that upon an incoming call to the Search List Number (SLN), the infrastructure will re-route the incoming call to the first attendant within the Search List (SL). If the call request to the first attendant is unsuccessful, then the infrastructure will attempt to re-route the call request to the second attendant in the SL, and so on until either an attendant answers or the end of the SL is reached.

Supplementary services cannot be associated with the SLN.

There is no restriction on the addressing domains of the attendants within the SL.

The Served User (SU) should be able to specify a number of SLs.

6.3 Include Call (IC)

The IC is a supplementary service which enables a served user A, while being involved in an active call (original call) with user B, to make a second call to user C and have this new party included in the original call. This new party does not have to be predefined and can be anyone irrespective of that party belonging to the TETRA system or not.

6.4 Call Forwarding Unconditional (CFU)

This service permits a called user (the served user) to have the network send all incoming calls, or only those with a specific basic service, addressed to the served user's ITSI, to another number. The ability of

the served user to originate calls is unaffected. If this service is activated, calls are forwarded regardless of the condition of the termination.

6.5 Call Forwarding Busy (CFB)

This service permits a called user (the served user) to have the network send all incoming calls, or only those with a specific basic service, addressed to the served user's ITSI and which meet a busy condition, to another number. The ability of the served user to originate calls is unaffected.

6.6 Call Forwarding on No Reply (CFNRy)

This service permits a called user (the served user) to have the network send all incoming calls, or only those with a specific basic service, addressed to the served user's ITSI and which meet no reply, to another number. The ability of the served user to originate calls is unaffected.

6.7 Call Forwarding on Not Reachable (CFNRc)

This service permits a served user to have the TETRA Network send all incoming calls, or only those associated with a basic service, addressed to the called mobiles directory number, but which is not reachable, to another number. The ability of the served mobile subscriber to originate calls is principally unaffected, but practically it is affected if the mobile subscriber is deregistered if there is radio congestion or if the mobile subscriber is for example, out of radio coverage. If this service is activated, a call is forwarded only if the mobile subscriber is not reachable.

NOTE: This supplementary service is considered to be applicable only to mobile subscribers, as a LS is always considered as reachable.

6.8 Call Authorized by Dispatcher (CAD)

CAD is defined as the ability of the dispatcher to verify and approve a call request before the call is allowed to proceed.

The supplementary service may also apply to the dispatcher authorisation of incoming calls to TETRA users. The incoming calls may be generated inside or outside of the operator's TETRA domain.

The service enables immediate interception of calls due to the following conditions:

- category of calling user;
- restricted basic service request;
- restricted destination address;
- restricted area.

6.9 Barring of Incoming Calls (BIC)

BIC enables barring restrictions for incoming calls to be set. The served user is able to change the activation/deactivation of the categories as shown below:

- all incoming calls (presumes all basic services);
- all incoming calls when outside home TETRA network;
- all incoming calls from certain identified users;
- all incoming calls from certain identified networks;
- to group numbers;
- call types.

These categories can be applied independently to each basic service.

6.10 Barring of Outgoing Calls (BOC)

BOC enables barring restrictions for outgoing calls to be set. The served user is able to change the activation/deactivation of the categories as shown below:

- all calls;

- international calls;
- calls through certain gateways going outside the TETRA system;
- calls through the inter system interface except calls to the home TETRA system;
- calls to subscribers outside the closed user group, (own fleet);
- calls outside the authorized geographical area;
- a basic service.

6.11 Call Report (CR)

This supplementary service provides the ability for the call originator (the served user), upon encountering that the called user does not reply or is busy or is not reachable, to leave his identity to the called party for subsequent call back.

6.12 Call Waiting (CW)

The CW supplementary service is defined as the possibility for a mobile or LS user to be notified of an incoming call whilst his termination is in the busy state. The user then has the choice of accepting, rejecting or ignoring the waiting call. When a user C attempts to connect to that termination the served user B is given an appropriate indication of the waiting call. The information sent to the served user B will be the type and the priority of the incoming call. The information presented to the served user B will then depend on type and functionality of the terminal.

The maximum number of waiting calls at any one time per busy subscriber is a network option. It is recommended that this should be one waiting call.

6.13 Calling line identification presentation

This service is offered to the called party and provides the calling party's number to the called party. The number provided should be sufficient to enable the called party to return the call.

6.14 Connected line identification presentation

This service is offered to the calling party and provides the called (connected) party's number to the called party. The number provided should be sufficient to enable the calling party to repeat the call.

6.15 Calling/connected line identification restriction

This service is offered to a party in order to restrict presentation of that party's number to another party.

6.16 Call Hold (CH)

When the CH supplementary service is invoked, communication for the served user end point be interrupted and the resource should be released from use by the existing call, depending on system implementation (i.e. use of trunking procedures would normally mean that the resource is released end to end). If all resources are released, there may be problems in trying to regain the call on hold.

6.17 Call completion to busy subscriber

This service is offered to the calling user (served user). On encountering a busy called user, it allows served user to request that the network monitors the called user and notifies the served user when the called user becomes not busy. On response by the served user to that notification, the network will attempt to complete the call to the called user.

6.18 Call completion on no reply

This service is offered to the calling user (served user). On encountering a called user who does not answer, it allows served user to request that the network monitors the called user and notifies the served user when the called user becomes not busy after a period of activity. On response by the served user to that notification, the network will attempt to complete the call to the called user.

6.19 Short Number Addressing (SNA)

SNA is defined as the facility whereby the originator of a call can use a predefined abbreviated address instead of full address in call control activities. Short numbers are held in the infrastructure and are defined at provision time for each user.

Short numbers stored in the mobile station are considered to be outside the scope of the TETRA standard.

6.20 Priority Call (PC)

PC is a supplementary service that allows the infrastructure to give priority access to network resources to calls which have been sent with priority status. The priority level should not apply to the initial uplink access but should apply to the resources across the infrastructure and to the radio link at the called user.

The priority level is sent with the initial call set-up message, (or the network may select a default level if the user has not chosen a level), and the level may be indicated to the called user as part of normal call control information.

In a typical scenario there may be (eight) levels of PC, each one in turn giving an enhanced performance in times of network congestion. A call attempt that has been assigned a higher priority than another call attempt will be given resources by the infrastructure in preference to a call attempt with lower priority.

6.21 Pre-emptive Priority Call (PPC)

PPC is a supplementary service that enables the user to have resources allocated, even if this means that other calls with lower priority will be disconnected. PPC normally means the highest Access Priority Level (APL) at uplink access and highest Priority Level (PL) across TETRA networks.

If the required resources are unavailable (i.e. occupied by other users), a call with pre-emptive priority will automatically cause the oldest calls with the lowest Call Retention Value (CRV) using such resources to be disconnected. The PPC will be given the released resources. (It is possible that some networks may prefer a different process for determining resource priority).

In the event where the destination TETRA address is already engaged on an established call the PPC has the ability to interrupt and pre-empt the call at the destination address, unless the established call has a sufficiently high CRV that the incoming PPC cannot pre-empt.

The operator should be required to provide a correspondence between Pre-emptive Priority Values (PPV) and CRVs.

If the PPL is the same or less than the CRV of the established call, then pre-emption cannot take place.

Retrieving the called user from an individual call should automatically force release the established call. Retrieving the called user from a group call will depend upon whether the called user is the call owner of the group call. If the called user is the group call owner then the group call may be force released upon pre-emption. If the called user is solely a participating member of the group then the group call will not be force released, and the called user should be removed from the ongoing group call.

In the case where there is no congestion across the air interface or the network resources and the Called User is not engaged, the call will be set up in the normal manner, but the call will keep the Call Retention Value of the Pre-emptive Priority Call.

6.22 Access Priority (AP)

AP is a supplementary service that enables the user to gain access to the TETRA system in times of radio link congestion. Preferential treatment should apply to the uplink access to the Control Functional Entities only.

The CFE enables the subscribers to:

a) make a registration;

b) update the subscriber database;
c) transfer of information for an occupancy level;
d) an APL subscription basis.

For the purposes of explanation only, case d) above is considered, where each mobile operating on the network has been assigned an APL by the network provider. In a typical scenario there may be eight levels of AP, each one in turn giving an enhanced performance in times of radio access congestion.

Under normal circumstances when there is no congestion, all mobiles will be permitted to make access attempts to the infrastructure. If the infrastructure wishes to regulate random access attempts the infrastructure will broadcast a change of APL. A user wishing to establish a call (or transfer information to the infrastructure) under these circumstances should firstly compare the broadcast message with his own APL (this will be an automatic procedure carried out by the mobile). If the user's APL is greater than or equal to the broadcast APL, then he should be able to make an initial call set-up attempt. If the user's APL is less than the broadcast APL then he should not be able to make an initial call set-up attempt at that time and should wait until the network changes the APL.

6.23 Advice of Charge (AoC)

This supplementary service is for further study. Advice of Charge is defined by CCITT Recommendation I.256 [2] as a service allowing the user paying for a call to be informed of usage-based charging information. This service is not meant to replace the charge metering inside the network which is considered to be correct in all cases.

AoC may be of one or more of the following types:

- charging information at the end of the call;
- charging information during a call;
- charging information at call set-up.

6.24 Discreet Listening (DL)

DL is defined as the facility whereby an authorized user may listen to one or more communications between TETRA subscribers (MS or LS) without any indication to any subscriber that the communication is being monitored. Identification of the talking parties should be given to the monitoring party. As an implementation option the monitoring party may further be allowed to enter into the conversation and/or may clear the call if required.

6.25 Ambience Listening (AL)

AL is defined as the facility whereby a control point may place a TETRA MS (or LS) into a special type of individual voice call teleservice whereby the called MS (or LS) is transmitting without any action from, or indication to, the called user. AL is only set-up if the called unit is not already engaged in a call. The standard does not preclude that during AL the called mobile may make and receive calls as normal.

6.26 Talking Party Identification (TPI)

TPI enables all connected parties to be made aware of the identity of the talking party. If SS-TPI is activated against a user's ITSI and the user has joined a multipoint call, he will not receive the identifications of the talking parties unless SS-TPI has been activated against the GTSI of the ongoing multipoint call. Activation against an ITSI is only applicable for individual calls.

6.27 Area Selection (AS)

AS allows a served user to define areas for selection and to choose, on a call by call basis, a selected area to be used by the TETRA network for establishing a call. For an individual or group call this will mean that called active users will not be alerted if they are outside the selected area/s.

6.28 Late Entry (LE)

During a multipoint speech call, the TETRA network can send LE indications related to this call, to allow latecomer users to join the ongoing speech call.

6.29 Transfer of Control (ToC)

ToC is defined as the facility whereby the owner of a multipoint call can subsequently transfer the ownership of the call to another TETRA user within the multipoint. The previous owner is able to release from the multipoint call, but the call continues in his absence.

Control of a call is defined as the authority to clear the call.

6.30 Dynamic Group Number Assignment (DGNA)

This service allows the served user to create groups. It may also be used to group participants in an ongoing call. The lifetime and management of the groups is outside the scope of the standard.

6.31 Call Retention (CR)

CR is a supplementary service that enables the user to define a relative level of protection of his call, (once established), against the probability of having the network connection resources pre-empted.

It is envisaged that every call in a TETRA network will be assigned a CRV, and, in the event that resources are required, the call with the lowest CRV, using the required resources, will be pre-empted. Pre-emption of resources may be necessary because the resources are required by pre-emptive priority calls. In the event where all calls have the same CRV, another mechanism may be used to determine which resource to take e.g. oldest, type of call, user.

The user may use this supplementary service to enhance the CRV of his calls in order to protect against pre-emption. The home operator should be required to provide a correspondence between PV and CRV.

7 Facilities

7.1 General

Gateways provide the necessary protocol translation and interfacing between TETRA and the outside world.

Table 6: Mapping of facilities onto TETRA clear and encrypted speech teleservices

Item no	Facility description	Individual call	Group call	Acknowledged group call	Broadcast message
	Access to gateways:				
1	Telephony				
1a	PSTN	X	X	X	X
1b	ISDN	X	X	X	X
1c	PBX	X	X	X	X
2	Facsimile				
2a	PSTN	X			
2b	ISDN	X			
3	PDN	X			X

7.2 Telephony access

Telephony access is a facility that is used to make a call to an external user using a PSTN/ISDN/PBX gateway. As all calls within a TETRA system have to be within the TETRA addressing domain, a PSTN/ISDN/PBX user cannot be addressed directly. Instead a gateway is addressed and subsequently given the address of the PSTN/ISDN/PBX subscriber selected. The gateway will translate this given address in a manner that the external line connected to the gateway understands.

For the TETRA user in the progress of setting up an outgoing call, the addressing of a gateway and the subsequent PSTN/ISDN/PBX addressing should not be visible. This could be achieved by sending both the address of the appropriate gateway and the address of the PSTN/ISDN/PBX subscriber in the same signal.

The facility telephony access is not used for incoming calls from PSTN/ISDN/PBX. When the gateway is used for an incoming call, the whole TETRA addressing domain can be used and there is therefore no constraint in calling either an individual or a group address.

It is not possible to include the gateway in a group call. If a PSTN/ISDN/PBX user is to be included in a group call then a router in the TETRA addressing domain which automatically invokes a PSTN/ISDN/PBX address should be included in the group address. The telephony access service is not used to connect an LS.

It is a facility of the gateway to support DTMF signalling.

7.3 Facsimile

Facsimile access will be provided as a general mechanism capable of supporting future facsimile enhancements.

7.4 PDN access

PDN access will be provided to allow interrogation of databases, and data transfer.

8 Standardized network procedures

8.1 General

In order to provide an efficient service to the system operator a number of standard services need to be supported by the system. The following services will be defined in the standard but it is an operator option which will be supported:

- registration;
- call re-establishment;
- authentication;
- attach/detach;
- log-in/log-out;
- disable terminal;
- data flow control;
- interrogation of terminal equipment identity;
- network management and call statistics.

8.2 Registration

8.2.1 Roaming within the same system

During the "idle" state the mobile terminal continuously evaluates the need to select another base station to provide a communication path. When the mobile terminal decides to change base station, a registration procedure may be required This is initiated by the mobile terminal resulting in an update of the Location Register (LR) in the system.

The SwMI then may send a request for authentication to the mobile terminal. The received information from the mobile terminal is examined and checked against the information about the mobile terminal held by the SwMI. If the SwMI finds the authentication valid, an acknowledgement is sent to the mobile terminal. If the authentication reveals unauthorized use, the SwMI will prohibit further use of the mobile terminal (see subclause 8.7).

8.2.1.1 Location area and paging area

A location area is the area in which a mobile terminal can move freely without updating the location information maintained in the network. The paging area is the area in which a mobile is paged.

To facilitate mobility management a mobile terminal may be temporarily registered in a number of location areas so that a mobile terminal may travel freely between the areas without the need to re-register.

The SwMI will page the mobile terminal in every location area where it is registered.

8.3 Migration to another system

Normally the mobile terminal continuously evaluates the need for selecting a new base station only within its home system.

If, after exhaustive searching of the home control channels, the mobile terminal finds only control channels of another TETRA system it may attempt to register on this as a visited system.

The visited system examines the registration request. Depending on the inter-operator agreement and the roaming mobile information available at the visited system, registration and authentication may proceed under local control or further information may be sought from the home system operator. In the latter case the visited system sends an inter-system roaming enquiry to the home system of the mobile terminal. The home system decides if the mobile terminal is authorized to use the visited system and sends an acknowledgement to the visited system together with relevant information about the mobile terminal. If the home system reveals that the mobile terminal is not authorized to roam to the visited system, the inter-system roaming request from the visited system is not authorized.

When the visited system receives the reply from the home system a positive or negative acknowledgement is sent to the mobile terminal.

If the migration is authorized by the home system, the visited system may send a request for authentication to the mobile terminal. The response from the mobile terminal is examined and checked against the information about the mobile terminal held by the system. If the system finds the authentication valid, a positive acknowledgement is sent to the mobile terminal. If the authentication reveals unauthorized use, the system will prohibit further use of the mobile terminal (see subclause 8.7).

8.4 Call re-establishment

The constraints on call re-establishment are tele/bearer service dependent. A speech call requires a relatively fast call re-establishment and may be able to tolerate some limited loss of information. On the other hand a data service may allow a temporary break in service but not a loss of information.

If the call is to be re-established in an adjacent location area then the mobile terminal should re-register before the call can be re-established. To a large extent the speed of re-establishment depends on the forewarning a mobile terminal is able to give to the SwMI about its need to select a better communication path. If the mobile terminal is registered on the preferred base station before the call is handed over then there need be no disruption of the communication.

8.4.1 Speech call re-establishment

A seamless cellular-style handover is not required. There is nevertheless a requirement to make the call re-establishment imperceptible to the user where possible. This can be done by performing the call re-establishment at pressel release. Several methods are feasible, each offering a different level of performance.

8.4.1.1 Fast call re-establishment

A mobile terminal, on detecting low received signal quality (low signal strength/high BER/high C/I), automatically monitors signal quality on adjacent base stations during the call and makes the information available to the infrastructure together with a call re-establishment request. The infrastructure investigates the feasibility of the request based on signal quality, load sharing etc. and registers the mobile terminal on the new base station. On pressel release the mobile is explicitly directed to the traffic channel on the new base station. If required authentication can be performed on the traffic channel on the new base station.

8.4.1.2 Simple call re-establishment

When an active mobile terminal detects that the signal quality is becoming low, it can begin the call re-establishment process by sending a special request to the infrastructure to commence transmitting presence check broadcasts in adjacent cells. On pressel release the mobile should hunt for the control channel on the best adjacent cell signal, perform registration and wait for the presence check broadcast. The call will then be set up in the normal way in the new cell.

This is a variation of the late entry procedure (see subclause 6.28).

There will be a substantial break in reception as the mobile hunts for the control channel and waits for the presence check.

8.4.1.3 Manually invoked call re-establishment

A low performance manually initiated handover could be provided if call re-establishment during a group call is required. It is envisaged that the mobile makes known to the user poor transmission quality either by aural or visual means. The user can then optionally initiate call re-establishment in which the mobile hunts for a better channel, registers and requests to rejoin the ongoing call (perhaps with an IC). Clearly this is not instantaneous and part of the ongoing call will be missed. However the user has initiated the process and may be tolerant of its limitations.

NOTE: The channel hunt can take some considerable time and there is a chance that by the time the traffic channel has been re-established the call may have cleared down.

For call re-establishment involving a group call the late entry supplementary service (see subclause 6.28) may be used.

8.4.2 Data call re-establishment

Flow control (see subclause 8.8) in data services makes call re-establishment less critical than for speech services.

8.5 Authentication

The primary purpose of the authentication service is to help the operator to identify fraudulent use of subscriber terminals. If fraudulent use of subscriber terminals is detected, then the operator should decide which countermeasures are appropriate. As one of these countermeasures, the operator may choose to disable the subscriber terminal (see subclause 8.7).

A secondary purpose of authentication may be for the mobile terminal to authenticate a network with which the mobile terminal is in contact.

Fraudulent use of subscriber terminals includes:

- impersonating a subscriber identity;
- failure to fulfil contractual obligations (e.g. bad debt) while continuing to use the system;
- using a stolen subscriber terminal.

A procedure similar to GSM would seem most appropriate.

A possible example of the authentication procedure is as follows. Authentication of the mobile is performed using command-response pairs, which are 32 bit random numbers linked by a security algorithm. When a user pays subscription a key is distributed by the operator in the Subscriber Identity Module (SIM). This key is also stored in the subscriber information database as part of the functional entity referred to as the authentication centre. When a mobile registers in a new location area (LA) the authentication centre evaluates a list of five command-response pairs and forwards these to the LA on which the mobile registered. Each of these pairs may be used only once as the mobile moves from base site to base site in the LA. The network sends the command number to the mobile and the mobile calculates the response and returns this to the network. The network then checks it against the expected response and decides on the validity of the mobile.

Operators of small private systems may feel that the above mechanism is too complicated for the security of their system. The operator should therefore have the option to decide whether or not to use the secure authentication procedure. The system could either give a command for the mobile to formulate a response or could authenticate the International TETRA Subscriber Identity (ITSI) in the subscriber database.

8.5.1 Attach/detach procedures

Attach/detach procedures notify the infrastructure of a terminal's status. This is in contrast to simply powering up or down during which the SwMI is not explicitly informed.

In the detach procedure the SwMI is notified that a terminal has entered an inactive state and is unable to receive traffic. Conversely attach notifies the SwMI that a terminal has entered the active state.

Potential advantages over simply powering up and powering down are:

- the SwMI performs less paging since only attached terminals are paged;
- traffic to detached terminals can be quickly rejected or re-routed.

8.5.2 Mobile terminal attach

After the mobile terminal has powered up and an appropriated internal initialisation sequence has been completed, the mobile terminal determines if it can regain contact with the base station it was connected to before the power down period. If so an attach procedure is initiated and a time delay for attachment is set up in the mobile terminal. If a service request is generated within this time period, it will be used as an "active" indication to the SwMI. If no such request is generated within the given time delay, the mobile terminal sends an attach signal to the SwMI. The SwMI then changes the status of the mobile terminal to active in the SwMI database.

If changes applicable to the mobile terminal have been made in the SwMI database and if the SwMI has not been able to transfer these changes to the mobile terminal the SwMI may decide to send SwMI information to the mobile in order to update the databases of the mobile terminal.

If messages to the mobile terminal are stored in the network or application mailbox, a transfer of the content of the mailboxes to the mobile terminal may be initiated.

If at power on the mobile terminal can not regain contact with the previous base station it should enter a hunt procedure to acquire a suitable control channel before sending the attach message.

If the mobile terminal has entered a new location area it may be required to re-register. Registration will implicitly attach the mobile terminal.

8.5.3 Mobile terminal detach

Before the mobile terminal is actually powered off, the contents of the transmit buffers in the mobile terminal are examined and the whole or part of it either transferred to the SwMI (if possible) or returned to the user application. The mobile terminal then sends a detach message to the SwMI.

The SwMI changes the status of the mobile terminal to detached in the SwMI database. All traffic to the mobile terminal are rejected or put in the network mailbox if the originator so requests.

8.5.4 System fails to contact mobile terminal

After multiple unsuccessful attempts of the SwMI to contact the mobile terminal, the SwMI may decide that the mobile terminal is not reachable and that the mobile terminal should be considered as detached. The SwMI changes the status of the mobile terminal in the SwMI database to detached and all further traffic will be rejected or stored in mailbox if the originator so request.

The mobile terminal itself will probably not be aware of the change of its status in the SwMI database. It is therefore essential that any further traffic from the mobile terminal to the SwMI automatically initiates a change of the detached status of the mobile terminal in the SwMI database.

8.6 Log-in/log-out

This service allows the subscriber to be separated from the terminal equipment identity. The subscriber can then log-in to any terminal in the system (perhaps necessitating a password, smartcard or other security feature) and have the network direct incoming traffic to that terminal.

8.7 Disable terminal

Procedures to disable the participation of specific mobile and line connected terminals from the Tetra system should be defined in the standard. Corresponding re-enable procedures should be defined. This service covers the transmitter over-ride requirement.

8.7.1 Unauthorized use of the system

If the result of an authentication reveals unauthorized use, the SwMI sends an order to the mobile terminal prohibiting all further traffic to and from the mobile terminal. This order is presented to the user. The new disabled status of the mobile terminal is noted in the Location Register of the SwMI and the network control centre may be notified.

8.7.2 Barring of mobile terminal transmission

The SwMI may decide to temporarily inhibit all traffic from the mobile terminal to the SwMI if for example a subscription has expired or in case of an unsettled bill.

In order to do that the SwMI sends an inhibition order to the mobile terminal and changes the status of the mobile terminal in the SwMI database. When the order is received at the mobile terminal it is presented to the user.

If the SwMI decides to allow traffic from the mobile terminal again, a new order is sent to the mobile terminal and the status is changed in the SwMI database.

8.7.3 Erroneous mobile terminal behaviour

After multiple receptions of erroneous traffic (e.g. incomplete frames or incorrect contents of frames) from a mobile terminal, the SwMI may decide to temporary prohibit the mobile terminal to send traffic. This service may also be used to de-activate faulty mobile terminals which may for instance be jammed permanently on transmit.

An order to stop all further traffic from the mobile terminal is sent from the SwMI to the mobile terminal.

This order is also presented to the user of the mobile terminal. The SwMI changes the status of the mobile terminal. The SwMI changes the status of the mobile terminal in the SwMI database to show that no traffic to or from the mobile terminal is allowed. The SwMI may also alert the Network Control Centre (NCC) for further actions.

No traffic to or from the mobile terminal may be issued before the SwMI has indicated permission to resume the traffic.

8.8 Data flow control

8.8.1 XOFF - Mobile terminal temporary stops traffic from system

In order to temporary stop the traffic from the SwMI to the mobile terminal (caused by for example overload of the mobile terminal), the mobile terminal may send an "XOFF" signal to the SwMI.

When the SwMI receives an "XOFF" signal, the status for the mobile terminal is temporarily changed. All further traffic to the mobile terminal is buffered in the SwMI.

The traffic is resumed when the mobile terminal sends an "XON" signal, as described below.

8.8.2 XON - Mobile terminal resumes traffic from system

When the mobile terminal has the capability to receive further traffic, an "XON" signal is sent to the SwMI. The SwMI will change the status for the mobile terminal and resume the traffic.

8.8.3 XON/XOFF - SwMI controls data flow from a mobile terminal

The SwMI should be able to control data flow from the mobile terminals in the uplink path in a similar manner to the mobile control in the down link path (as described in subclauses 8.8.1 and 8.8.2).

8.9 Interrogation of terminal equipment identity

Each terminal equipment should have a unique Terminal Equipment Identifier (TEI) which should be programmed only by the terminal equipment manufacturer. The primary purpose of this security feature is to locate stolen terminal equipment or investigate irregular use of the system. The TEI can be demanded at any stage of a call. When interrogated the terminal should send its TEI to the relevant system control terminal.

8.10 Network management and call statistics

The information to be available at the Network Management Unit (NMU)/Transit Network (TN) interface should be functionally defined.

Services providing call statistics and traffic recording capability should not be standardized.

8.10.1 Call statistics services

The requirement for obtaining call statistics is likely to vary greatly between different TETRA systems. The operator will decide which call statistics which are to be made available by the TETRA system according to the operator's needs and strategies. It is therefore the task of the operator to select equipment which is capable of supplying the required call statistics.

It may be possible for co-operating TETRA systems to exchange some call statistics for inter-system working purposes.

8.10.2 Traffic recording services

The traffic recording service, although not standardized will, where offered, provide the capability to provide call traffic and associated call statistics in a suitable format to a recording device. The traffic recording will be possible for selected individual communications or for categories of target communications. Traffic recording will also be possible for all communications. Where the traffic recording service is offered, a method for selecting which traffic to record will be necessary.

The traffic recording service should only be made available to authorized users.

9 Voice and data time sequence diagrams

9.1 Introduction

A conceptual model of the TETRA trunked mobile radio system is developed which allows the dynamic states of the system to be described.

A four state model can be used to describe the operation of functional blocks in the TETRA system.

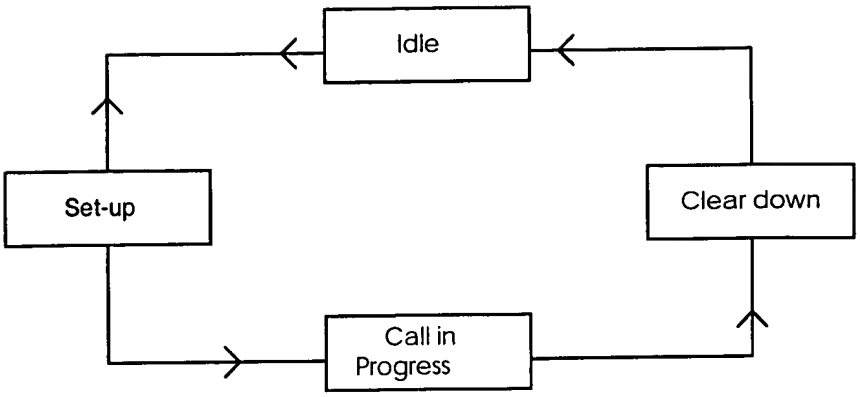

Figure 4: The operation of function blocks in the TETRA system

This model is applicable for all parts of the system:

Within the line connected parts of the infrastructure (i.e. for multi-site and inter-system working):

- at a single base station;
- within each mobile;
- to describe each call state.

The model will be developed to show the progression between the states in the call, the states in the mobile and the states in the infrastructure. It also provides a basis for exploring interaction and interconnection between, for instance, mobiles in different call states. The model can be used to illustrate the essential transactions, timing and interactions for an inter-site or inter-system call. The basis of using this model to develop time sequence descriptions of system operation will be examined and examples given of important operational scenarios.

9.2 Development of the model

9.2.1 General

The TETRA systems can be considered to operate at five independent but interacting hierarchical levels, namely:

inter-system; system; single base station; mobile; call.	network operation " "

In the following subclauses system procedures are described for each of these levels and examples given to illustrate the required interaction between levels.

9.2.2 Single base station operation

9.2.2.1 Broadcast phase

The base station is continuously transmitting the following control and identification information:

- system identity (e.g. country code, operator code, area code etc.);
- system timing information (e.g. slot synchronisation, frame synchronisation etc.);
- control channel organization and loading information (e.g. announce slot structure especially for random access);
- requests for or denial of system registrations.

Information (such as paging messages addressed to a particular mobile or group of mobiles) is transmitted on a per call basis. This information logically belongs to the set-up phase even though it is

initiated in the broadcast phase. Thus in the dynamic model it is necessary to span two states in the transitory entry and exit periods.

NOTE: The logical information channels needed to progress from one state to another and also to communicate between states on different levels are outside the scope of this ETR.

9.2.2.2 Set-up phase

Exchange of addressing and control information occurs between the infrastructure and a mobile in order to establish a connection.

Support of all teleservices and bearer services are required (single point and multipoint).

User may invoke all supplementary services except 3 (IC), 8 (CW), 10 (CH) during this phase.

9.2.2.3 Call in progress

Call has been successfully established.

Further supplementary services may be invoked by the user (3 & 10).

System infrastructure may interject control information during this phase, such as 8 (Call Waiting), 14 (Pre-emptive Priority Clear Down) or indeed any system clear down (time-out, clear by other party etc.).

Normal control functions need to be supported during this phase such as transferring pressel on/off tokens, timing advance and perhaps receive signal quality. The system may demand user authentication at any stage during an ongoing call.

During a group call the system may periodically broadcast invitations for group members who missed the call set-up to join the call (see subclause 6.27).

9.2.2.4 Call clear down

May be signalled on the traffic channel or on a separate (logical) signalling channel.

9.2.2.4.1 User initiated clear down

At the end of a call the mobile informs the system that the call has finished by transmitting the "on hook" signal. This is usually sent on the traffic channel. The mobile then returns to the control channel to look for further calls.

The system issues a clear down message to all other mobiles involved in the call. In multipoint calls only the call initiator can clear a call. The system also releases all other resources.

9.2.2.4.2 System initiated clear down

The system may instigate call clear down for a number of reasons:

- call length time-out (operator option);
- activity time-out in message trunking;
- pre-emptive priority over ride.

9.2.3 Mobile operation

Largely mirrors infrastructure signalling but on the basis of one base station to many mobiles.

9.2.3.1 Control channel acquisition and monitor control channel

A mobile terminal is in the "idle state" when it is "actively receiving" the control channel (i.e. decoding addresses looking for its own address in messages) but is not within a call and has no message transfer requirements. To reach the "idle state" the mobile should successfully complete several procedures:

- control channel retention;
- control channel acquisition;
- registration (network should deal with mobility management);
- authentication;
- validation;
- battery saving techniques.

After switching on a mobile should first synchronise to the system broadcast information and then search for and acquire a suitable control channel. This process is sometimes called hunting. Registration and authentication (see definitions in subclauses 8.2 and 8.5) may need to be performed before the system allows the mobile to make a call. The infrastructure may require the mobile to register its presence before paging the mobile.

During the idle phase the mobile monitors the control channel decoding addresses and looking for its own address in messages.

9.2.3.1.1 Entry to the IDLE state

There are three entry points to the idle state:

- at mobile switch-on;
- after unsuccessful call set up, and;
- on call clear down.

The major difference between these entry points relates to the amount and accuracy of data held by the mobile. Clearly when the mobile initially switches on it will have little current information about the active control channels in a particular coverage area and the system will have little information about the mobile's registration, authentication or validation.

It will be much easier for a mobile to re-establish "ready" after an unsuccessful call set up or after clearing down a successful call set up. Ideally the mobile would immediately re-establish the ready state but in practice it may need to hunt for the control channel and if there is any change in system parameters it may be required to re-register.

9.2.3.1.2 Exit from the IDLE state

There is only one valid exit point from the "idle" state and that is into the call set up state.

9.2.3.2 Set-up

Information is exchanged between the infrastructure and mobile. Five elements of this procedure have been identified:

- wake up (if in battery economy mode);
- presence check on control channel (if required);
- transfer to the traffic channel;
- acknowledgement on traffic channel (if required);
- traffic information transfer (voice or data).

Further elements need to be taken into account, especially concerning invoking supplementary services during this phase, conveying this information to the infrastructure, checking subscriber data base to ensure these services have been subscribed. On successful conclusion of this stage the mobile progresses to the call in progress stage.

9.2.3.3 Call in progress

Terminals are now concerned primarily to communicate with each other rather than signal to the infrastructure. However even during the traffic phase a substantial amount of control information should be supported to allow "traffic channel acknowledgements", caller authentication, notification of call waiting, call hold and transfer to waiting, priority pre-empt, IC and speaker identification during a call.

Trunking philosophy (message, transmission etc.) has a large impact on calls in progress, e.g. radio channel may be relinquished but line connections retained.

9.2.3.4 Call clear down

Mobile relinquishes traffic channel and returns to monitoring the control channel. If the call is on "hold" the system will retain details of the mobile and the call reference for subsequent re-connection. The system may optionally retain line resources. When the call is complete all radio and line resources should be cleared of traffic and returned to the resource pool.

9.2.4 Call management

Essentially a mobile can only participate in one call at a time. However a mobile may be participating in one call while having another call on hold. This mobile will use only one traffic channel switched between the two parties. The infrastructure will manage the switch between parties on instructions from the mobile. If the party on hold is a radio connected terminal it should relinquish the traffic channel (concerns remote base station only) and monitor the control channel for further signalling.

10 Voice and data functional groupings

10.1 Introduction

Transmission of circuit mode speech and data calls contain two distinct elements; a control phase when the terminals exchange information with the infrastructure and a traffic phase when they exchange information with each other. Mobile terminals spend most of their time in the control phase; monitoring the control channel waiting for calls, setting up calls or clearing down calls. In the traffic phase primarily traffic information is carried. However even during the traffic phase a substantial amount of control information should be supported to allow "on channel acknowledgements", caller authentication, notification of call waiting, call hold and transfer to waiting, priority pre-empt, IC and perhaps even speaker identification during a call.

It would seem most useful to associate the phases of a call with the logical function being performed. Thus the four state model (Idle, Set-up, In progress, Clear down) developed is maintained.

Five stages can be identified in establishing a circuit mode call:

- wake up (if in battery economy mode);
- presence check on control channel (if required);
- transfer to the traffic channel;
- acknowledgement on traffic channel (if required);
- traffic information transfer (voice or data).

The first stage is carried out in the so called "idle phase" when the mobile monitors the common control channel. Once alerted the mobile enters the "set-up" phase to perform stages two and three. After successfully transferring to the traffic channel the mobile may be required to provide an acknowledgement of its participation in the call.

10.2 Description of stages in establishing a call

10.2.1 Wake up

The normal quiescent state of a mobile terminal is to actively monitor the system common control channel in those periods when it expects to receive its messages. Depending on the user application this usually comprises over 90 % of the time and may even be more. For this reason it is in the quiescent (sometimes called the "idle") state that most battery economy can be achieved. The most common technique is to restrict the time when the radio needs to be active. This gives substantial battery economy but has some disadvantages.

Call set-up time is increased because the mobile can only be addressed in restricted time windows. Group call operation has added complexity if members of the group are accessed in different time windows (i.e. each member has to be activated before the complete group can be addressed). Infrastructure has to keep a record of whether a particular mobile has invoked the economy mode and if so in which time window they can be accessed. This should be done before any call set-up is attempted.

10.2.2 Presence check on the control channel

The infrastructure may call the mobile terminal to check its availability before setting up a call. The acknowledgement may indicate either that the mobile is switched on and within coverage (off-air call set-up) or, with user intervention, that the user is available and willing to receive the call (full off-air call set-up). The choice between these two is an operator option.

10.2.3 Transfer to traffic channel

When all the necessary signalling has been carried out to set up a call and all the required resources are available the called and calling parties are informed of the traffic channel that has been allocated for their use and are transferred to it at an appropriate time.

10.2.4 On channel acknowledgement

Depending on the protocol there may be a requirement for the mobile terminals to acknowledge the infrastructure that the parties to the call have successfully transferred to the traffic channel.

10.2.5 Call in progress

Information transfer between the parties in a call.

10.3 Basic teleservice

10.3.1 Individual call

Table 7

<table>
<tr><th></th><th>Phase</th><th>Case 1A</th><th>Case 1B</th><th>Case 2</th></tr>
<tr><td rowspan="3">Control Phases</td><td>Wake up</td><td>Individual</td><td>Individual</td><td rowspan="3">Individual
combined
(None)
combined
Individual</td></tr>
<tr><td>Presence</td><td>Individ ACK</td><td>combined
Individ ACK</td></tr>
<tr><td>Transfer</td><td>Individual</td><td>Individual</td></tr>
<tr><td rowspan="2">Traffic Phases</td><td>Channel ACK</td><td>None</td><td>None</td><td>Individual</td></tr>
<tr><td>In progress</td><td>Exclusive CH</td><td>Exclusive CH</td><td>Exclusive CH</td></tr>
</table>

10.3.1.1 Case 1

This corresponds to the normal individual call set-up where a presence check is performed on the control channel before setting up the call. Case 1B is slightly faster than 1A since it combines the wake up and ACK stages. It depends on the address structure and battery economy strategy whether these two stages can be merged.

10.3.1.2 Case 2

Gives a faster call set-up than case 1, checking the called party presence on the traffic channel only after setting up the call. This situation is considered spectrally inefficient by many operators but required by some operators (especially emergency services) wanting rapid call set-up. If the on-channel acknowledgement fails then the call is immediately cleared down.

10.3.2 Group call

Table 8

	Phase	Case 1	Case 2	Case 3	Case 4	Case 5
Control Phases	Wake up	Group addr	Group addr	Group addr	Group addr	Group addr
	Presence	combined (None)	None	combined (None)	None	Group
	Transfer	combined Group addr	Group add	combined Group addr	Group add	Group addr
Traffic Phases	Channel ACK	None	None	Group	Group	Group
	In progress	Shared chan	Shared chan	Shared chan	Shared chan	Shared chan

The group call is characterized in that all members of the group have a common address. Individual acknowledgements are not required (see subclause 10.3.4). Group acknowledgements are not allowed. Transfer to the traffic channel uses the group address.

10.3.2.1 Case 1

This is the optimum situation where all members of the group belong to the same battery economy regime. They can be woken up and transferred at the same time. It also corresponds to zero battery economy mode.

10.3.2.2 Case 2

If the group spans several battery economy regimes then all should be active before the group call is set up. Late entry to an ongoing group call (due to battery economy, multi-site, external terminal etc.) are for study.

10.3.2.3 Case 3

All members of the group belong to the same battery economy regime. They can be woken up and transferred at the same time. Group acknowledgement on the traffic channel is an optional feature that allows the system to rapidly establish presence of group members on a particular site without registration database searching. The base station can detect mobile responses even though there may be collisions. The call would be immediately cleared down on sites receiving no response. The procedure for late entry to group calls on a site where the call is not established is for study.

10.3.2.4 Case 4

Same as case 3 but group spans several battery economy regimes.

10.3.2.5 Case 5

Similar to cases 3 and 4 above but the presence check is made on the control channel before the call is set up. The call would not be set up on sites registering no response.

10.3.3 Broadcast message

Table 9

	Phase	Case 1	Case 2
Control Phases	Wake up	Group addr	Group addr
	Presence	combined (None)	None
	Transfer	combined Group addr	Group addr
Traffic Phases	Channel ACK	None	None
	In progress	Shared chan	Shared chan

Remarks apply as for cases 1 and 2 of group call. The main differentiating factor is that on the traffic channel mobile transmit is disabled.

10.3.4 Acknowledged group call

Table 10

	Phase	Case 1	Case 2
Control Phases	Wake up	Group addr	Group addr
	Presence	combined (None)	None
	Transfer	combined Group addr	Group addr
Traffic Phases	Channel ACK	Individual	Individual
	In progress	Shared chan	Shared chan

Similar restrictions to group call are imposed:

- all members of the group have a common address (as well as their individual addresses);
- transfer to the traffic channel uses the group address but individual transfer may be offered in some situations (e.g. solitary roamed mobile);
- group acknowledgements are useful only for resource management but individual acknowledgements are required for the presence check.

Mobiles are treated as a group on the control channel but are required to acknowledge individually on the traffic channel. This gives the most rapid set-up. Wake up and transfer to traffic channel should be combined if at all possible (i.e. case 1A preferred).

If the individual acknowledgements indicate that insufficient members of the acknowledged group are present then the call should be cleared down. The precise clear down criteria are for study.

Battery economy techniques based on limited time access window add complexity and may potentially slow down rapid access performance.

11 Detailed interface requirements

11.1 Physical interfaces

Table 11

Name	Between	Standardization required
VD air interface	MOB-SwMI & OMOB-SwMI	Yes
Direct mode air interface	MOB-MOB & MOB-OMOB	Yes
LS-ISDN interface	LS-ISDN-SwMI	Yes
SwMI-TN interface	SwMI-ISDN	Yes
	SwMI-PSTN	Yes
	SwMI-PBX	Yes
	SwMI-PDN	Yes
	SwMI-Leased Line	Yes (range of standard TBD)
Q interface	IVDU-LS	TETRA encoded voice: No
	IVDU-MOB IVDU-LS	Circuit speech: Yes
		Circuit data: Yes
		CONS packet data: Yes
		CLNS packet data: Yes
		CLNS packet data: Yes
		Call control: Yes
MOB-MMI LS-MMI	IVDU-MOB IVDU-LS	(Partially)
SMI-1	NMU-SwMI	No
SMI-2	NMU-TN	No (functional only)
X.25	X.75-SwMI	Yes

11.2 Functional interface

Table 12

Name	Between	Standardization required
VD air interface	MOB-SwMI & OMOB-SwMI	Yes
Direct mode air interface	MOB-MOB & MOB-OMOB	Yes
LS-ISDN-SwMI	LS-SwMI	Yes
SMI-2	NMI-TN	Yes
Inter-system interface	SwMI & SwMI-2	Yes

12 Inter-system inter-working and inter-operability

It should be possible for independent V+D TETRA systems to exchange meaningful information using standard TETRA message protocols. These inter-system message protocols will enable any two TETRA systems to co-operate to offer services which are not limited to a single TETRA system.

With the exception of the discreet monitoring service, the system management service, (the subscriber management service) and the call statistics and traffic recording service, each of the services described in Clause 6 of this ETR should be standardized so that inter-system inter-working of the respective service should be possible.

The TETRA system operator should decide whether to offer inter-system inter-working.

12.1 Level of inter-working

If inter-system inter-working is offered, the TETRA system operator should decide which services are to be supported for the purpose of inter-system inter-working. This is called the inter-working capability of the system.

The specific services supported for the purpose of inter-system inter-working between a particular pair of TETRA systems is called the level of inter-working. The level of inter-working should be agreed between the respective TETRA system operators. For each pair of TETRA systems, the level of inter-working can be agreed on a service by service basis.

12.2 Grade of service for inter-working

Invocations of services using inter-system inter-working may have different performance and quality expectations compared to invocations of services which do not use inter-system inter-working.

The standard should enable a choice of inter-system capability to be supported depending on operator requirements.

Some operators will co-operate very closely to the extent that high performance inter-working will be required as if their two systems were a single system.

Other operators will support only a lower grade of service for inter-system working.

12.3 Inter-operability profiles

For services which are implemented according to the standard, if the Switching and Management Infrastructure (SwMI) supports the service, any subscriber terminal which implements the service is guaranteed to obtain the service from the SwMI when subscribed.

An individual subscriber terminal may offer a particular set of services. This is called the inter-operability profile of the subscriber terminal. Likewise the SwMI may offer a certain set of services. This is the inter-operability profile of the SwMI.

The level of inter-operability between the individual subscriber terminal and the individual SwMI consists of all of the services common to both profiles.

Each service would normally need to be subscribed before the service could be obtained. Subscribed services should be guaranteed regardless of the manufacturing source of the respective items of equipment.

13 Key considerations for voice and data services

13.1 Open channel/open traffic mode

Tetra should be capable of operating so that, from a user perspective, an operational capability and performance equivalent to that of traditional open channel operation is obtained without the requirement for dedicated air interface resources.

Any concerned user may enter or leave the "open channel" at any time.

13.2 Direct mode operation

Direct mode operation should be standardized and should be provided by the use of separate channels outside the control of the network.

Direct mode is defined as a mode of simplex operation where mobile subscriber radio units communicate using radio frequencies which are outside the control of the network and without the intervention of any base station.

13.3 Duplex operation

The service requirement is for semi-duplex operation but full duplex should not be precluded.

13.4 Terminal autonomy

The system will be designed to optimise the terminal autonomy using the best technical solutions like battery saving mode and radiated power control.

13.5 Portability

The system design should include the use of hand-portable units. The radio interface may support indoor coverage which means coverage inside buildings.

13.6 Data compression

Data compression should be handled by the application or by the system in order to achieve the best spectrum efficiency.

13.7 DTMF signalling

TETRA should be capable of supporting external applications which use DTMF signalling.

13.8 Vocoder upgrade

The TETRA standard should provide an upgrade path for Vocoders. The technical evolution in this field is very fast and it is expected that the 4,8 kbit/s of todays vocoders will give way to 3,6 kbit/s by 1994, and to 2,4 kbit/s with speaker recognition by 1996-1997. Therefore, as it is necessary to have a well defined and stable basic teleservice built around the TETRA codec (7,2 kbit/s), it is as important to allow future adaptation of lower bit rate codecs without an essential re-definition of the TETRA standard.

14 Support of non-standard applications

Applications will not be standardized within TETRA. Any application may be developed which is supported by the TETRA telecommunication services. Applications can be achieved using additional software and hardware in the terminals and hosts.

The following list contains examples of applications which may be supported. Standards already exist for some of the applications and it is recommended to use them when applicable:

- secure speech;
- secure data;
- road transport informatics; (see NOTE)
- interactive word processing;
- file transfer;
- fixed image;
- access to data bases (e.g. police);
- fleet management (computer aided);
- approximate vehicle location by examination of the location register;
- automatic vehicle location using auxiliary position location equipment in the vehicle;
- facsimile transmission;
- message handling systems;
- key management;
- some railway applications.

NOTE: Road transport informatics as an application of mobile data.

15 Man-machine interfaces

15.1 Man-machine interface of the subscriber unit

In order to be user-friendly, aural and visual indicators should be standardized where appropriate.

Due consideration should be given to ready operation of all controls under all conditions.

16 Conformance testing

16.1 Radio aspects

Where appropriate, existing specifications should either be used directly or as used as a basis for conformance testing of TETRA equipment. For example, I-ETS 300 113 [5] should be used as the basis for conformance testing the radio aspects.

16.2 Intra-system testing

To support the system integrity requirements of the network management user system integrity signalling should be provided.

The following summarises the purpose of the required system integrity signalling:

- testing of communication link performance and quality and conformance to specification;
- testing of SwMI service profile and performance;
- testing of manufacturers' subscriber terminal service profiles and performances;
- testing of inter-system capability and performance;
- testing for proprietary purposes.

16.3 Integrity of inter-system working

In order for the integrity of inter-system working (where offered) to be tested, specific inter-system signalling is required. This may consist of test signals capable of being passed between two co-operating systems.

The areas of interest for inter-system integrity signalling are listed below:

- testing of inter-system capability;
- testing of inter-system subscriber mobility management;
- testing of system to system communication link performance and quality and conformance to specification;
- testing for proprietary purposes.

17 Security

Individual users, subscribers and network operators should, if they wish, be protected against the undesirable intrusion of third parties.

The general principle on which TETRA system security will be based is outlined in the basic reference model for OSI: ISO 7498-2 [8].

The TETRA protocol will be defined to support all of the listed features but implementation of these security features in a particular network is an operator option.

Security profiles will be defined as a combination of security services having a certain level, the level being the strength of a mechanism within a service.

The profiles should correspond to:

- profile with protection for billing only;
- profile for user privacy on the air interface;
- high security profile.

High priority should be put on end to end security, air interface security, signalling security, air interface key management, air interface authentication.

The corresponding services should be:

- user information confidentiality for speech (end to end and air interface);
- user identity confidentiality;

- group identity confidentiality;
- signalling information confidentiality;
- data integrity and data origin authentication for signalling data;
- functions for air interface key management;
- user authentication(air interface);
- network authentication.

There are a number of over-the-air services such as discreet monitoring, ambience listening, terminal disable, dynamic group number allocation that may require special secure procedures to prevent their misuse.

Annex A (informative): Attributes definitions

A.1 Scope

The purpose of this Annex is to define the CCITT attributes used to characterize bearer services and teleservices supported by the TETRA. The annex also identifies possible values for each of the attributes.

Reference is made to the following documents:

- ITU-T Recommendation I.140 (ISDN) [1];

- prETS 300 580 [6].

Only lower layer attributes have been considered so far. The main purpose of the ETR is to identify simplifications and extensions relative to the base reference of ITU-T Recommendation I.140 [1]. The simplifications and extensions adopted in prETS 300 580 [6] are included, together with some new extensions.

A.2 Bearer services

Table A.1 gives a detailed list of the attributes, within the three groupings of:

- dominant attributes;
- secondary attributes;
- qualifying attributes.

It can be seen that the dominant attributes, as marked, are used to define the bearer service category. Similarly, the secondary attributes, as marked, are used to define the bearer service within the bearer service category. Finally, the qualifying attributes are used to further define and qualify the bearer service within its category.

Table A.1: Categories of attributes - bearer services

Attributes	Dominant attributes Define bearer service category	Secondary attributes Define bearer service within a category	Qualifying attributes Further qualify a bearer service
Information transfer Attributes			
1 Information transfer mode	X		
2 Information transfer rate	X		
3 Information transfer capability	X		
4 Structure	X		
5 Establishment of communication		X	
6 Communication configuration		X	
7 Symmetry		X	
Access attributes			
8 Access channel and rate			X
9.1 Signalling access protocols			X
9.2 Information access protocols			X
General attributes			
10 Supplementary services provided			X
11 Quality of service			X
12 Inter-working possibilities			X
13 Operational and commercial			X

A.3 Teleservices

Teleservices provide the full capacity for communication by means of terminal and network functions. They can be described from a static point of view by a group of three categories:

- low layer attributes;
  - information transfer attributes;
  - access attributes;
- high layer attributes;
- general attributes.

Table A.2 gives a detailed list of the attributes within three category types for teleservices.

Table A.2: Categories of attributes - teleservices

Attributes	Dominant attributes
Low layer attributes:	
Information transfer attributes	
1. Information transfer mode 2. Information transfer rate 3. Information transfer capability 4. Structure 5. Establishment of communication 6. Symmetry 7. Communication configuration	
Access attributes	
8. Access channel and rate 9. Access protocol 9.1 Signalling access protocol layer 1 9.2 Signalling access protocol layer 2 9.3 Signalling access protocol layer 3 9.4 Information access protocol layer 1 9.5 Information access protocol layer 2 9.6 Information access protocol layer 3	
High layer attributes	
10 Type of user information 11.1 Layer 4 protocol functions 11.2 Layer 5 protocol functions 11.3 Layer 6 protocol functions 11.4 Layer 7 protocol functions	X
General attributes	
12 Supplementary services provided 13 Quality of service 14 Inter-working possibilities 15 Operational and commercial	

A.4 Definitions

A.4.1 Attributes based on ITU-T Recommendation I.140

Information transfer mode

This attribute describes the operational mode for the transport and switching of user information through the TETRA.

Possible values:

- circuit;
- packet connection oriented data;
- packet connectionless data.

Information transfer rate

This attribute describes either the bit rate (circuit mode) or the throughput (packet mode). It refers to the transfer of information at the service access points.

Possible values:

- multiple rates from **TBD** to 19200 bps (circuit mode);
- packet mode throughput.

Information transfer capability

This attribute describes the capability associated with the transfer of different types of information.

Possible values:

- unrestricted digital information;
- full rate coded speech;
- half rate coded speech.

Structure

This attribute describes the capability of the TETRA to deliver information to the destination service access point in a structure that was presented at the source service access point.

Possible values:

- full rate codec integrity; (NOTE)
- half rate codec block integrity; (NOTE)
- service data unit block integrity;
- unstructured (applicable for Voice teleservice);
- time slot sequence integrity;
- block integrity.

NOTE: I.140 codings removed.

Establishment of communication

This attribute describes the mode of establishment associated to the telecommunication service used to establish and release a given communication.

Possible values:

- demand; mobile originated (MO);
- demand; mobile terminated (MT);
- demand; mobile originated or terminated (MO, MT);
- reserved;
- permanent.

Symmetry

This attribute describes the relationship of information flow between two or more service access points (or reference points) involved in a communication.

Possible values:

- unidirectional;
- bi-directional symmetric;
- bi-directional asymmetric.

Communication configuration

This attribute describes the spatial arrangement for transferring information between two or more service access points.

Possible values:

- point-to-point;
- multipoint (any-to-all others);
- broadcast (point-to-multipoint).

Access channel and rate

This attribute describes the channels and their bit rate used to transfer the user information and/or signalling information at a given access point.

Possible values:name of the channel and the corresponding bit rate

- Radio Channel: Codec Rate;
- ISDN Channel: 64 kbit/s;
- PSTN: Analogue;
- other: **TBD**.

A.4.2 Attributes specific to TETRA

Transmission mode (duplex mode)

This attribute describes the mode of operation for bi-directional communications.

Possible values:

- full duplex;
- half duplex (user controlled);
- half duplex (network controlled).

Half duplex is also known as semi duplex.

"User controlled" means that the instantaneous transmission direction is controlled by the service user(s). This is the usual case for speech services.

"Network controlled" means that the instantaneous transmission direction is controlled by the network (by the service provider in the OSI sense). This is the usual case for data calls, but could apply to certain speech services (e.g. ambience listening).

Selection of called parties

This attribute describes the method used to address the called parties.

Possible values:

- individual addressing;
- (single group addressing);
- (exploded group addressing) (address list).

Comment: This may be better considered as a feature of call establishment, not an attribute.

Multipoint configuration

This attribute describes the communication configuration of multipoint calls.

Possible values:

- 1 channel per user;
- 1 channel per site.

Called party presence

This attribute describes the called party presence mode to be used during connection establishment.

Possible values:

- no acknowledgement;
- soft acknowledgement;
- (hard acknowledgement).

"Soft" acknowledgement means that acknowledgement of all called party presence's is requested, but the connection may proceed in the absence of a response.

"Hard" acknowledgement means that acknowledgement of all called party presence's is requested, and the connection should only proceed if all parties provide a positive acknowledgement.

Fixed resource allocation

This attribute describes the relationship between fixed resources allocated to a particular communication and the state of that particular communication.

Possible values:

- resources allocated prior to establishment;
- resources allocated at establishment;
- (resources dynamically allocated in response to traffic).

Radio resource allocation

This attribute describes the relationship between radio resources allocated to a particular communication and the state of that particular communication.

Possible values:

- transmission trunking;
- message trunking;
- permanent dynamic resources (allocated as needed);
- permanent static resources (allocated at connection establishment).

Annex B (informative): Attributes tables for bearer services

Bearer services provide the capability for information transfer between access points and involve only low level functions. As a first step, categories for each of the bearer services should be established.

Table B.1: Bearer service dominant attributes

Bearer service category number	ATT no	Bearer service category attributes
1 Circuit mode Speech	1	Information transfer mode: Circuit
	2	Transfer rate: 7,2 kbit/s
	3	Information transfer capability: Unrestricted digital information, constant delay
	4	Structure: Time slot sequence integrity.
2 Packet mode data connection oriented	1	Information transfer mode: Packet connection oriented data
	2	(a) Information transfer rate: up to a maximum of (TBD) packet/s throughput
		(b) Information transfer time: (TBD)
	3	Information transfer capability: Unrestricted digital information
	4	Structure: Service data unit block integrity.
3 Packet mode data connectionless	1	Information transfer mode: Packet connectionless data
	2	(a) Information transfer rate: up to a maximum of (TBD) packet/s throughput
		(b) Information transfer time: (TBD)
	3	Information transfer capability: Unrestricted digital information
	4	Structure: Service data unit block integrity.
4 Circuit mode protected data	1	Information transfer mode: Circuit
	2	Information transfer rate: In multiples of 4,8 kbit/s up to a maximum of 19,2 kbit/s
	3	Information transfer capability: Unrestricted digital information, constant delay.
	4	Structure: Octet sequence integrity
5 Circuit mode unprotected data	1	Information transfer mode: Circuit
	2	Information transfer rate: In multiples of 7,2 kbit/s up to a maximum of 28,8 kbit/s
	3	Information Transfer capability: Unrestricted digital information, constant delay.
	4	Structure: Octet sequence integrity.

Bearer services secondary attributes

The bearer services contained within each of the bearer services categories are identified here. To achieve this, it is necessary to define the secondary and qualifying attributes (as identified in table C.1) for each of the bearer services within their categories. They are as in table B.2.

Table B.2: Bearer services secondary and qualifying attributes

Bearer service category number	Bearer service number	Bearer service description	Value
1 Circuit Mode Speech + Data	1.1 Circuit Mode Unprotected Speech and Data (pt-pt)	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to Pt
		8 Access channel and rate:	TBD
		9 Access protocols:	
		9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	See table 2
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
1 Circuit Mode Speech + Data	1.2 Circuit Mode Unprotected Speech and Data (multipoint)	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Multipoint
		8 Access channel and rate:	TBD
		9 Access protocols:	
		9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD

(continued)

Table B.2: Bearer services secondary and qualifying attributes (continued)

Bearer service category number	Bearer service number	Bearer service description	Value
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	See table 2
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
1	1.1	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Broadcast
Circuit	Circuit	8 Access channel and rate:	TBD
Mode	Mode	9 Access protocols:	
Speech +	Unprotected	9.1 Mobile station	
Data	Speech and	9.1.1 Signalling access protocols layer 1	TBD
	Data	9.1.2 Signalling access protocols layer 2	TBD
	(Broadcast)	9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	See table 2
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
2	2.1	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to Pt
Packet	Connection	8 Access channel and rate:	TBD
Mode data	Oriented	9 Access protocols:	
Connection	Packet	9.1 Mobile station	
Oriented	Data	9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD

(continued)

Table B.2: Bearer services secondary and qualifying attributes (continued)

Bearer service category number	Bearer service number	Bearer service description	Value
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	Not applicable
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
3	3.1	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to Pt
Packet	Conn'less	8 Access channel and rate:	TBD
Mode data	Packet	9 Access protocols:	
Conn'less	Data	9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols Layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	Not applicable
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
3	3.2	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to Pt
Packet	Special	8 Access channel and rate:	TBD
Mode data	Conn'less	9 Access protocols:	
Conn'less	Packet	9.1 Mobile station	

(continued)

Table B.2: Bearer services secondary and qualifying attributes (continued)

Bearer service category number	Bearer service number	Bearer service description	Value
	Data (Pt-Pt)	9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	Not applicable
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
3	3.3	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to multipt
Packet Mode data Conn'less	Conn'less Packet Data (Multipoint)	8 Access channel and rate:	TBD
		9 Access protocols:	
		9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	Not applicable
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
3	3.4	5 Establishment of communication:	On demand
		6 Symmetry:	Unidirectional

(continued)

Table B.2: Bearer services secondary and qualifying attributes (concluded)

Bearer service category number	Bearer service number	Bearer service description	Value
		7 Communication configuration:	Broadcast
Packet Mode data Conn'less	Special Conn'less Packet Data (Broadcast)	8 Access channel and rate:	TBD
		9 Access protocols:	
		9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	Not applicable
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD
4	4.1	5 Establishment of communication:	On demand
		6 Symmetry:	Bi-directional
		7 Communication configuration:	Pt to Pt
Circuit Mode data	Circuit Mode Data Protected	8 Access channel and rate:	TBD
		9 Access protocols:	
		9.1 Mobile station	
		9.1.1 Signalling access protocols layer 1	TBD
		9.1.2 Signalling access protocols layer 2	TBD
		9.1.3 Signalling access protocols layer 3	TBD
		9.1.4 Information access protocols layer 1	TBD
		9.1.5 Information access protocols layer 2	TBD
		9.1.6 Information access protocols layer 3	TBD
		9.2 Fixed terminal	
		9.2.1 Signalling access protocols layer 1	TBD
		9.2.2 Signalling access protocols layer 2	TBD
		9.2.3 Signalling access protocols layer 3	TBD
		9.2.4 Information access protocols layer 1	TBD
		9.2.5 Information access protocols layer 2	TBD
		9.2.6 Information access protocols layer 3	TBD
		10 Supplementary services provided:	See table 5
		11 Quality of service:	TBD
		12 Inter-working possibilities:	TBD
		13 Operational and commercial:	TBD

Annex C (informative): Attributes tables for teleservices

Individual call for TETRA clear speech

Table C.1: Attributes for teleservices

Information transfer attributes	value
1 Information transfer mode	Circuit
2 Information transfer rate	N/A
3 Information transfer capability	Full rate coded speech
4 Structure	Full rate codec block integrity (33 Hz TBD)
5 Establishment of communication	MO, MT
6 Symmetry	Bi-directional Symmetric
7 Communication configuration	Point-to-point
Access attributes	
8 Access channel and rate Mobile station 8.1.1 Access rate 8.1.2 Transmission mode	 Codec rate Half duplex
LS 8.2.1 Access rate 8.2.2 Transmission mode	 TBD Duplex

History

Document history	
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